U.S. Army Center for Health Promotion and Preventive Medicine

USACHPPM

CONSERVARE SALUTEM

EPIDEMIOLOGICAL CONSULTATION REPORT
NUMBER 29-HE-8370-98
INJURY INCIDENCE AND INJURY RISK FACTORS AMONG U.S. ARMY BASIC TRAINEES (INCLUDING FITNESS TRAINING UNIT PERSONNEL, DISCHARGES, AND NEWSTARTS)
FORT JACKSON SOUTH CAROLINA 1998

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Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

- ★ *Integrity is the foundation*
- ★ *Excellence is the standard*
- ★ *Customer satisfaction is the focus*
- ★ *Its people are the most valued resource*
- ★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

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13. ABSTRACT *(Maximum 200 words)*
An epidemiological consultation (EPICON) was requested by the Commander, U.S. Army Training Center, Ft Jackson, SC, to assist in the development of an Army Center for the Study of Training-Related Injuries. This EPICON 1) compared injury rates with a previous investigation, 2) examined injuries in special Basic Combat Training (BCT) subgroups, and 3) explored injury risk factors. Cumulative incidence of one or more injuries in the present study (men and women, respectively), was 37% and 63%, much higher than the 15% and 38% found previously at Ft Jackson in the fall of 1997. Men coming from the Fitness Training Unit (FTU) were more likely to get injured (57% vs 36%, $p=0.01$) and less likely to graduate (55% vs 82%, $p<0.01$), compared to men who went directly to BCT. On the other hand, women coming from the FTU had similar injury incidence (62% vs 63%, $p=0.78$) and first-time graduation success (60% vs 68%, $p=0.14$) compared to women who directly entered BCT. Men who were discharged were more likely to be injured than those who were not discharged ($p<0.01$) while female discharges were equally likely to be injured compared to women who were not discharged ($p=0.38$). Injury incidence was high among the newstart-outs (recycles), 65% for men and 97% for women, primarily accounted for by individuals sent to the Physical Training and Rehabilitation Program (PTRP) for injury recovery. Risk factors for time-loss injuries (i.e., injuries with one or more days of limited duty) among the men included training company; older age; lower performance on diagnostic push-ups, sit-ups, or the 2-mile run; cigarette smoking prior to BCT; no prior sports participation; less walking or hiking in the last month; lower peak VO2; low upper body static strength; and lower or higher levels of hamstring flexibility. Risk factors for time-loss injuries among women included training company; low performance on the diagnostic push-ups, sit-ups, or the 2-mile run; cigarette smoking in the last year; less leisure time physical activity; and lower peak VO2. Efforts to improve the fitness of trainees prior to BCT, basing FTU standards on injury incidence and graduation success measures, and further investigation of why injury incidence differs among units are recommended.

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EPIDEMIOLOGICAL CONSULTATION NO. 29-HE-8370-98 INJURY INCIDENCE AND INJURY RISK FACTORS AMONG U.S. ARMY BASIC COMBAT TRAINEES (INCLUDING FITNESS TRAINING UNIT PERSONNEL, DISCHARGES, NEWSTARTS) FORT JACKSON, SOUTH CAROLINA 1998

EXECUTIVE SUMMARY

1. INTRODUCTION. At the request of the Commander, U.S. Army Training Center, Ft Jackson, South Carolina, the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) conducted an epidemiological consultation (EPICON) to assist in establishing a U.S. Army Center for the Study of Training-Related Injuries at Ft Jackson. This EPICON had the following three major purposes.

a. To corroborate a low injury incidence found in a recent study of basic combat trainees at Ft Jackson. A pilot study conducted in October-December 1997 found a cumulative injury incidence of 15% and 38% for men and women, respectively. This was considerably lower than average cumulative incidences of about 25% and 50% (men and women, respectively) found in past Basic Combat Training (BCT) investigations.

b. To examine injury incidence and lost duty days among special Basic Combat Training (BCT) subgroups, including Fitness Training Unit (FTU) personnel, discharges, and newstarts. The effectiveness of the FTU was an area of special concern.

c. To examine risk factors for injuries with special attention to direct measures of physical fitness obtained from physiological tests.

2. METHODS.

a. A prospective cohort design was used. The cohort included all trainees in two basic training battalions (3d Battalion, 13th Infantry Regiment and 1st Battalion, 28th Infantry Regiment) who had a medical record (n=733 men and 452 women). Cases were trainees who had an injury in his or her medical record during the 8-week BCT cycle. Medical record data extracted included the date of the visit, duration of symptoms, diagnosis, body part, disposition, and any days of limited duty. Additional information was obtained from discharge packets, battalion discharge summaries, rosters from the FTU, rosters from the Physical Training and Rehabilitation Program (PTRP), and data from the Master Tracking System (MTS). The MTS was a computerized database, maintained at the company level, which contained trainee demographics and Army Physical Fitness Test (APFT) results.

b. Prior to basic training, detailed physiological measures were obtained on a subsample of trainees (n=170 men and 166 women). These measures included peak VO_2 (continuous treadmill running protocol), static and dynamic strength (upper and lower body), leg power (vertical jump), flexibility ("bender box"), and body composition (by dual-energy X-ray absorptiometry, skinfolds, and the Army circumference techniques). A questionnaire addressing lifestyle characteristics and past injuries was also administered.

3. FINDINGS AND CONCULSIONS. The findings and conclusions for the three major purposes as listed in paragraph 1 above for this EPICON are as follows:

a. Comparison of injury incidence in this study with a recent study at Ft Jackson.

(1) The cumulative incidence of injuries (any injury) in the current study was 37% for men and 63% for women (risk ratio (women/men)=1.7). Cumulative incidence of time-loss injuries (an injury requiring one or more days of limited duty) was 29% for men and 54% for women (risk ratio=1.9). Cumulative incidence of a PTRP injury (injury requiring temporary removal from training by sending trainee to the PTRP) was 4.8% for men and 11.9% for women (risk ratio=2.5). Lower body injuries accounted for 83% of the male injuries and 87% of the female injuries. Injuries to the knee and below accounted for 51% of male injuries and 59% of female injuries. Cumulative incidence of stress fractures and stress reactions was 2.6% for men and 8.1% for women. The rate of injuries by week of training was similar for both men and women: rates increased through week three, then declined.

(2) The present study did not corroborate the low injury incidence found at Ft Jackson in the study conducted October to December 1997. One possible explanation is the differences in weather conditions. Maximum dry bulb temperatures averaged (±SD) 92±6°F in the current study (May to July 1998) and 61±8°F in the previous study. Exercise in hotter environments may result in higher cardiovascular and metabolic stress making injuries more likely through increased fatigue, impaired tissue healing, and altered gait patterns. Other possible reasons for differences in injury incidence include training differences in the battalions, location of the battalions with regard to the training areas, and temporal changes in training practices between the battalions.

b. Comparison of injury incidence and limited duty days in specific BCT subgroups with emphasis on FTU effectiveness.

(1) Men coming from the FTU (N=40) into the training battalions were less aerobically fit than men entering the battalions directly from the Reception Station (first diagnostic 2-mile run times = 20.3 minutes (min) versus (vs) 17.3 min, p<0.01). Compared to men coming directly into basic training from the Reception Station, FTU men were more likely to get injured (57% vs 36%, p=0.01) and less likely to graduate (55% vs 82%, p<0.01). On the other hand, women coming from the FTU (N=82) had aerobic fitness equal to those going directly to the training battalions from the Reception Station (first diagnostic 2-mile run times=21.6 min vs 21.5 min, p=0.86). When compared to women coming directly from the reception station, FTU women had similar injury incidence (62% vs 63%, p=0.78) and graduation success (60% vs 68%, p=0.14).

(2) About 12% of the male cohort and 23% of the female cohort were discharged. Poor entry level performance (Chapter 11) accounted for 71% of these discharges, and medical conditions that existed prior to service accounted for 27%. Men who were discharged were more likely to be injured than those who were not discharged (65% vs 33%, p<0.01). Women who were discharged were equally likely to be injured compared to women who were not discharged (67% vs 62%, p=0.38). Risk factors for discharge for both men and women included lower educational level and lower performance on the first diagnostic test for push-ups, sit-ups, or 2-mile run.

(3) Newstart-outs (personnel leaving the training battalions we studied but expected to return to training in another battalion) accounted for 5% of the male cohort and 7% of the female cohort. Reasons for becoming a newstart-out included a PTRP injury (66%), APFT failure (16%), basic rifle marksmanship failure (12%), missing training (4%), and being returned to the FTU (3%). Injury incidence was high among the newstart-outs, 65% for men and 97% for women; however, this was primarily accounted for by the PTRP. Injury incidence among newstart-outs who were not sent to the PTRP was 21% for men and 86% for women.

(4) The number of days of limited duty was higher in the subgroups (FTU, discharges, and newstarts) than in full-cycle trainees (those who started and finished with the units under study). Male full-cycle trainees experienced on average 1.0 day of limited duty per trainee, while female full-cycle trainees experienced 2.7 days per trainee. Men who were discharged had 5.8 days of limited duty per trainee, while women had 8.7 days per trainee. The average±SD time a male discharge was in the unit was 31.7±14 days, while female discharges averaged 30.0±13.1 days. Male newstart-outs had 13.1 days of limited duty per trainee while female newstart-outs had 20.0 days per trainee. Most of the limited duty days of the newstarts were given to

those sent to the PTRP. Men sent to the PTRP had 21.2 days of limited duty per trainee (95% of all male newstart-out days), while women sent to the PTRP had 22.4 days per trainee (88% of all female newstart-out days). The average time a newstart-outs was in the unit was (Mean±SD) 30.7 ±11.6 days for men and 30.7 ±12.2 days for women.

c. Examination of injury risk factors with emphasis on direct physiological measures of fitness.

(1) Risk factors for time-loss injuries among the men included training company; older age; lower performance on first diagnostic push-ups, sit-ups, or the 2-mile run; cigarette smoking prior to BCT; no prior sports participation; less walking or hiking in the last month; lower peak VO_2; low upper body static strength; and lower or higher levels of hamstring flexibility.

(2) Risk factors for time-loss injuries among women included training company; low performance on the diagnostic push-ups, sit-ups, or the 2-mile run; cigarette smoking in the last year; and lower peak VO_2.

(3) Risk factors for a PTRP injury include lower performance on push-ups or the 2-mile run for both men and women.

(4) The direct association of low peak VO_2 and higher injury risk suggests that associations between the 2-mile run time and injuries were due to cardiorespiratory endurance and not some other aspect of the run, such as pacing ability or motivation. The finding that both push-ups and upper body strength are related to injury risk reinforces the importance of both upper body strength and upper body muscular endurance in BCT, at least in men.

4. Recommendations.

a. Continue efforts to improve the physical fitness of trainees prior to BCT. Low aerobic fitness and low upper body strength, especially, appear to be important risk factors in BCT since trainees with these risk factors are more likely to get injured and to be discharged.

(1) The FTU is one method of improving fitness prior to BCT and should be continued and refined. No objective criteria have been established for FTU entry or exit and this could be accomplished using some of the criteria suggested here (graduation and injury incidence).

(2) A fitness test in the Military Entrance Processing Station (MEPS) may screen out the least fit enlistees before they enter basic training. A long-term solution is to support efforts to emphasize the importance of physical activity and physical fitness in elementary and high school.

b. Increase the intensity of aerobic training for men in the FTU. While women coming from the FTU were highly successful, men leaving the FTU had slower two-mile run times and were less successful in BCT. Improving aerobic fitness in men by increasing the intensity of training may reduce injuries in BCT. On the other hand, it is possible that male injury rates will slightly increase in the FTU because of the increase in intensity. However, overall injury rates (FTU and BCT combined) may be lower because of the greater rest and recovery time in the FTU.

c. Conduct an investigation to determine if injury incidence differs in different seasons in BCT. The same training unit should be investigated to reduce the possibility of training variations between units. The present study suggests that injuries are lower in BCT cycles conducted in the fall than they are in BCT cycles conducted in the spring-summer. This may have implications for the allocation of medical care suggesting more care is needed in the summer and less in the winter.

d. It is known that there is a dose-response relationship between the amount of training and risk of injury: the more physical activity a group does, the more injuries will occur. It is also known that there are thresholds of training above which fitness does not improve substantially but injury rates still increase. It may be that lower volumes of training in the early weeks of training, more measured progression of training, and greater emphasis on ability groups will reduce injury rates while still achieving adequate fitness.

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EPIDEMIOLOGICAL CONSULTATION REPORT N0. 29-HE-8370-98 INJURY INCIDENCE AND INJURY RISK FACTORS AMONG U.S. ARMY BASIC COMBAT TRAINEES (INCLUDING FITNESS TRAINING UNIT PERSONNEL, DISCHARGES, AND NEWSTARTS) FORT JACKSON, SOUTH CAROLINA 1998

1. REFERENCES. Appendix A contains references used in this report.

2. INTRODUCTION. This epidemiological consultation (EPICON) was initiated in response to a letter from MG VanAlstyne (Commander, U.S. Army Training Center and Ft Jackson, South Carolina) to BG Patrick Sculley (Commander, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)) requesting assistance in establishing an Army Center for the Study of Training-Related Injuries. To understand fully the basic training environment, a pilot study was conducted in October-December 1997. The final results of that investigation have been reported (83) and the recommendations were used to design and execute a second, more comprehensive study reported in this EPICON report. The major purpose of this second study was to determine injury incidence and risk factors for injuries during Basic Combat Training (BCT) with emphasis on special subgroups, including the Fitness Training Unit (FTU) personnel, discharges, and newstarts.

3. HISTORICAL BACKGROUND.

a. Injury Incidence. Injuries to basic combat trainees are of concern because of their frequency, because they result in significant loss of manpower, and because they can compromise training activities. Prior to 1997, surveys of basic training outpatient medical records (sick call visits) documented that the cumulative incidence of trainees seeking medical care for one or more injuries during the 8 weeks of basic training varied between 23% to 31% for men and 42% to 67% for women (10, 12, 67, 68, 90, 170). However, in a recent pilot study of basic trainees at Ft Jackson SC (October to December 1997), cumulative injury incidences of 15% and 38% were found for men and women, respectively (83). Suggested reasons for the lower incidences were changes in training involving a more gradual introduction of physical training (PT) compared to past BCT studies, or an increase in the number of requirements for graduation that may make trainees less likely to seek medical care for minor injuries. If current injury rates are lower at Ft Jackson than in the past, it would be advantageous to document and institutionalize the training practices that produce this lower injury rate.

b. Injuries and Fitness in Special BCT Subgroups (FTU, Discharges, and Newstarts).

(1) The FTU has been in existence at Ft Jackson since 1985. The goal of the FTU is to improve the fitness of trainees prior to BCT in hopes of increasing their chance of success in BCT. Within a few days of arrival at the Reception Station at Ft Jackson, each trainee takes a fitness test. If they pass the test they go on to BCT, if not they enter the FTU. Criteria for men and women to pass the test during the summer of 1998 are in Table 1. Trainees who enter the FTU perform a specific physical training program and some limited military training. Criteria to exit the FTU and go on to BCT differ from the Reception Station fitness test (Table 1). If a trainee was sent to the FTU for a push-up or sit-up failure, they can go on to BCT as soon as they pass the new push-up or sit-up criterion; tests are given three times per week. At the time of this study, if the trainee was a run failure, he or she must stay in the FTU for a mandatory 3-week period and pass the exit criteria before entry to BCT. Currently (June, 1999), a trainee who is a run failure can proceed on to BCT as soon as he or she passes the run in tests conducted weekly.

Table 1. Minimum Criteria to Pass the Reception Station Fitness Test and Minimum Criterion to Exit the FTU

	Event	Men	Women
Reception Station Fitness Test Minimum Passing Criteria	Push-Ups (repetitions)	13	3
	Sit-Ups (repetitions)	17	17
	1-Mile Run (minutes)	9.0	11.0
Minimum Criteria to Exit the FTU	Push-ups (repetitions)	20	6
	Sit-Ups (repetitions)	21	21
	1-Mile Run (minutes)	9.0	11.0

(2) One study (33) found FTU personnel had higher sick call rates, and lower end-of-cycle fitness measures, but had similar discharge rates compared to non-FTU personnel. However, when this study was conducted, the only criteria for entry to the FTU were a low number of push-ups (<1 for women and <13 for men). The current standards differ as noted above. An investigation conducted more recently with the new criteria in place was limited by a very small sample size (83). However, the data in this latter study suggested injury incidence for female FTU and non-FTU women was identical. Male FTU had a higher injury incidence than non-FTU men (29% vs 15%), but this was not statistically significant because of the small sample of FTU men (n=7). Further investigation of the effectiveness of the FTU is clearly warranted.

(3) Basic trainees who do not complete the BCT cycle are another subgroup of special interest because of the level of attrition currently experienced in the US military.

Ft Jackson SC post statistics indicate that between 1 Sep 97 and 25 Aug 98, 13% of all trainees were discharged before completing BCT. Individuals not completing their entire first-term military contracts may be as high as 36% (144). Most studies examining reasons for discharge have focused largely on psychological issues (13, 29, 106) and have not looked at injuries or physical fitness. One pilot study (83) suggested a higher injury incidence among male and female discharges (and newstarts) but sample sizes were very small. Another investigation (72) found that male and female discharges tended to be less physically active prior to BCT and female discharges (but not male discharges) tended to have more body mass and estimated body fat.

c. Injury Risk Factors.

(1) Previous investigations have identified a number of factors that put basic trainees at a higher injury risk. These risk factors may be categorized as either intrinsic or extrinsic in nature. Intrinsic factors are inherent characteristics of individuals, such as age, race, gender, anatomic characteristics, physical fitness, and the like. Extrinsic factors are variables outside the individual, such as PT programs, equipment, terrain, and weather conditions, which influence the risk of injury.

(2) Previously identified intrinsic risk factors include female gender (12, 68, 69, 71, 83, 90), older age (16, 48, 71, 83), white ethnicity (16, 48, 71, 83, 85), high foot arches (27, 49), excessive ($>15^{o}$) knee Q-angle (26), genu valgus (26), past ankle sprains (71), lower levels of aerobic fitness (68, 69, 83, 170), high and low extremes of back and hamstring flexibility (71), lower levels of physical activity prior to entry into service (48, 68, 69, 71), and tobacco use (71, 85). Less consistently demonstrated intrinsic risk factors (i.e., not demonstrated in all studies) include lower levels of muscular strength/muscular endurance and higher body fat (9, 68, 69, 71, 83, 170).

(3) Extrinsic risk factors that have been identified include greater running mileage during BCT (70, 71), and the use of older running shoes during training (48).

4. PURPOSES/OBJECTIVES - The present study was designed to further explore injury incidence and injury risk factors in gender-integrated units at Ft Jackson. The study had three major purposes.

a. The first purpose was to attempt replication of the lower injury rates found in the 1997 Ft Jackson study and to explore some potential reasons for this low injury rate.

b. The second purpose was to examine injury incidence and lost duty days in special populations at Ft Jackson. These special populations include individuals from the FTU, discharges, and newstarts, which have not been well investigated in previous injury studies. Special efforts were requested by MG VanAlstyne to examine whether or not the FTU was successful in reducing injuries and increasing graduation rates in BCT.

c. The third purpose was to examine injury risk factors, especially associations between injuries and direct measures of physical fitness. Previous investigations of injury risk factors have used "field" measures of physical fitness, (e.g., 2-mile run time, push-ups, sit-ups, and body mass index (BMI)). Measures that directly evaluate specific fitness components (20) have not been examined and may be important. For example, to determine if the association between injuries and 2-mile run time is related to aerobic power (or to some other component of the 2-mile run, such as pacing ability, motivation, etc.), it is necessary to directly evaluate aerobic power (i.e., measure VO_2max) and relate this measure to injury risk. Another example is body composition. There are conflicting data (69, 71, 83) on associations between injuries and surrogate measures of body fat (e.g., BMI). More direct body fat measures (using densitometry or dual energy X-ray absorptiometry) may resolve whether or not injury is related to body fat in BCT.

5. METHODS.

a. Study Design and Subjects. For this study a prospective cohort design was used. The cohort consisted of all trainees in two battalions (3d Battalion, 13th Infantry Regiment (3-13th) and 1st Battalion, 28th Infantry Regiment (1-28th) who had a medical record. Cases were defined as trainees in these battalions who had an injury recorded in his or her medical record. The 3-13th began training on 8 May 98 and graduated 1 July 98; the 1-28th began training on 15 May 98 and graduated 9 July 98. There were 5 companies in the 3-13th and 4 companies in the 1-28th. A description of activities in the 8-week BCT cycle is provided in Appendix B.

b. Physiological Test Subjects. There was a separate portion of the investigation that involved detailed physiological testing. Trainees were briefed in several large groups on the purposes and risks of this portion of the study and provided their written informed consent to participate. Because of the time limitations, not all subjects in the cohort performed these tests. A Medical Research and Materiel Command Human Use Review Committee examined and approved the study protocol. The investigators adhered to Army Regulation 70-25 on the use of volunteers as subjects of research.

c. Surveillance Data Sources.

(1) Surveillance data was obtained from battalion records, the McWethy Army Troop Medical Clinic, the FTU, the Physical Training and Rehabilitation Program (PTRP), and the Transition Point (discharges).

(2) Data included demographics; medical records (injury data); Army Physical Fitness Test (APFT) results; and information on FTU personnel, newstarts, PTRP personnel, and discharges, as described below.

(a) Demographics. Trainee demographics were obtained from both medical records and from the Master Tracking System (MTS). Medical record demographics were recorded from Department of the Army (DA) Form 88 (Report of Medical Examination) and included stature, body mass, ethnicity, gender, and date of birth (for age). The MTS was a company-level computer program that allowed the training cadre to follow the status of trainees during training. Personnel at the Reception Station placed information in the MTS shortly after the trainee arrived at Ft Jackson. The battalion-training cadre obtained this information when they picked up the trainees from the Reception Station. Demographic information from the MTS included gender, age, military rank, ethnicity, service component (i.e., active duty, Reserves, National Guard), educational level, and marital status. Data that overlapped in the medical records and MTS (age, gender, and ethnicity) were crosschecked.

(b) Medical Records (Injury Data).

1. For each trainee in the two battalions under study, we extracted information for each visit to a medical care provider from the medical record DA Form 3444-6 (Medical Record Folder). This information included the date of visit, duration of symptoms (reported by trainee), diagnosis, body part injured, side of body injured, disposition, and any days of limited duty. This information was typically available on one of three forms: DA Form 5181 (Screening Note of Acute Medical Care), Standard Form (SF) 600 (The Chronology of Medical Care) or SF Form 558 (Emergency Care and Treatment Form).

2. Although all injuries were recorded, the only injuries that were considered in the analysis were those that occurred while the trainees were in their BCT battalions. Similarly, the number of limited duty days included only those prescribed while the trainee was in his or her BCT unit.

3. Trainee medical care at Ft Jackson is described in Appendix C.

(c) APFT Data.

1. APFT data were extracted from the MTS. Raw scores for push-ups, sit-ups, and the 2-mile run (4) were recorded. The push-up and sit-up results were the maximum number that could be completed in separate 2-min periods. For the 2-mile run, the time it took to complete the distance was the performance measure. The first diagnostic APFT was taken within a few days of arrival in the battalion; the final APFT was taken in the sixth or seventh week.

2. We found that one of the battalions routinely eliminated individuals who left the battalion (newstart-outs, discharges) from their MTS. APFT data was recovered from drill sergeant records in most but not all cases. Thus, individuals who left the battalion are slightly underrepresented in the APFT statistics.

(d) FTU Personnel. As noted in paragraph 2 above, in order to enter basic training, each trainee must take a fitness test in the Reception Station. From the orderly room of the FTU, we obtained the names of FTU individuals who had entered either of the two battalions we were studying.

(e) Newstart Personnel.

1. Newstart-ins were trainees entering a BCT unit from another BCT unit because they did not complete mandatory training requirements in the first battalion. Trainees could have problems completing mandatory training requirements for a variety of reasons, such as injury, emergency leave, or inability to meet specific training standards. These trainees could come into the unit at any point depending on the nature of the problem.

2. Newstart-outs were trainees leaving the battalion because they could not complete required training in a particular unit. Trainees can be a newstart only once; if they fail to meet a training requirement a second time, they are discharged in accordance with Army Training and Doctrine Command (TRADOC) Regulation 350-6.

3. Newstart data was obtained from summaries provided by the battalion S-3 (Plans, Training, and Operations Section); from status boards in the company orderly rooms; and from direct conversations with Company Commanders, Company Executive Officers, Company First Sergeants, and Platoon Drill Sergeants. All data was coded as to the reason the trainee was newstarted and data sources were compared to assure the information was complete.

(f) PTRP Personnel.

1. One special category of newstarts involved trainees sent to or recommended for the PTRP. These trainees were injured to the extent they could not complete mandatory training. The Physical Therapy Clinic made the recommendation for the PTRP and determined when PTRP personnel could return to BCT. Trainees who entered the PTRP spent time recovering from their injuries. They also performed limited exercise and some military duties and training. For the purposes of this study, an individual was a PTRP-in or PTRP-out if they were entered or left, respectively, the battalions under study.

2. Names of individuals who were PTRP-ins or PTRP-outs were obtained room the orderly room of the PTRP unit. These names were compared to PTRP recommendations from rosters kept in the Physical Therapy Clinic and Company Status Boards to assure all PTRPs were accounted for.

(g) Discharges.

1. The records of all individuals discharged from service while at Ft Jackson, SC go through the Transition Point Headquarters. At the Transition Point, discharge packets were reviewed for the two battalions under study. Information obtained included the reason for the discharge as well as information from the medical record (as described above). Discharges were coded as to the nature of the discharge (i.e., soldierization, medical, etc.). Other information in packets (counseling statements, statements from trainees, relevant medical information, commander's evaluation, etc.) was also reviewed to obtain a more complete picture of why trainees were discharged. Discharge data was also obtained from summaries provided by the training battalion S-1 (Personnel Section) and was compared to that found at the Transition Point to assure the data was complete.

2. There are numerous reasons a trainee can be discharged, but most reasons fall into two major categories. These two categories are medical conditions that existed prior to service (EPTS discharge) or for entry-level performance. The latter category is often called an entry-level separation (ELS) or Chapter 11 discharge. ELS discharges are most often the result of trainees inability to adapt to the military environment because of lack of ability (cannot adequately perform critical military tasks) or for psychological reasons (inability to follow orders, personality problems, etc.).

3. One special category of Chapter 11 discharges was trainees who refused to go to the PTRP. At the time these data were collected, trainees were permitted to do this, but they became ELS discharges (as of this writing they are no

longer allowed to refuse PTRP). A PTRP refusal was coded as an ELS discharge in the database, but a second code included the PTRP refusal.

d. Physiological and Questionnaire Data. Trainees involved in the physiological testing completed a number of tasks to directly assess physical fitness, body composition, and anthropometric characteristics. After the informed consent briefing, they also completed a questionnaire. Not all trainees who volunteered could be tested because of time limitations. Physiological testing was conducted in a single session, and the order of tests was such that physically demanding tests were interspersed between two less physically demanding tests. Unless otherwise specified, testing was conducted with subjects in sneakers and PT outfit (shorts, t-shirt, underwear, and socks). Technical problems with equipment precluded testing of all subjects on all tests; thus, sample sizes differed slightly for each test.

(1) Maximal Oxygen Uptake. Aerobic power was directly measured using a continuous uphill treadmill running protocol. An initial 5-min warm-up was run at 0% grade and 2.68 $m \cdot sec^{-1}$ (6 miles per hour (mph)) for men and 2.24 $m \cdot sec^{-1}$ (5 mph) for women. If the heart rate was less than 150 beats/min by minute 5 of the warm-up, treadmill speed was increased 0.45 $m \cdot sec^{-1}$ (0.5 mph) for the remainder of the test. Following the warm-up, the treadmill grade was increased by 2% every 3 minutes until there was an increase of less than 2 $ml \cdot kg^{-1} \cdot min^{-1}$ (or 0.15 $l \cdot min^{-1}$) with an increase in treadmill grade, or until voluntary exhaustion. Volunteers wore a nose clip and were connected to the oxygen uptake measuring device by a mouthpiece. The on-line oxygen uptake system consisted of an Applied Electrochemistry® S-3A oxygen analyzer; a Beckman® LB-2 carbon dioxide analyzer; and a K.L. Engineering® flowmeter turbine, interfaced with a Hewlett-Packard® model 9122 computer. A single-lead electrocardiogram (EKG) was monitored by trained personnel during the test to determine heart rate and ensure the safety of the volunteer.

(2) Muscle Strength.

(a) Lifting strength was measured using the incremental lifting device(IDL) (157). The test simulated lifting a box with handles from ground level onto a 2-1/2 ton truck. Volunteers lifted handles attached to the carriage of a weight stack machine. The handles and weight stack were lifted vertically from 20 cm to 152 cm. The subject began the lift by grasping the handles of the weight carriage and assuming a bent-knee, straight back position with the head up and feet shoulder width apart. The load was accelerated upward by straightening the legs and pulling up on the handles of the load carriage, which were held in an overhand grip. The subject's wrists were simultaneously rotated under the handles and the load was lifted to a mark 152 cm above the ground. The initial load was 18.2 kg and was increased in 9 kg increments for men and 4.5 kg increments for women until the volunteer began to experience difficulty. Increments were then reduced by half (4.5 kg for men and 2.3 kg for women) until the volunteer was unable or unwilling to complete the lift using a safe technique. Volunteers were provided detailed instruction on lifting techniques, practice trials, and inter-trial rest periods of a minimum of 1-minute at near maximum loads.

(b) Three measures of isometric strength were obtained (86, 87). Isometric upper body strength was measured in a secured, seated position with the upper arm parallel to the floor and the elbow flexed to 90 degrees. The volunteer grasped a suspended 45.7-cm long piece of aluminum tubing (3.2 cm diameter) and pulled downward with maximal voluntary effort. Static lower body strength was measured in a seated position with the knee angle set at 90 degrees. The volunteer pushed maximally against a stationary foot rest (86). Static upright pulling strength was measured in a semi-squat position with the knee bent, the head up, and the back straight. Volunteers grasped a taped aluminum bar 38-cm high and attached by a cable to a load cell mounted on a wooden platform. They pulled vertically on the bar with maximal voluntary effort (87). For all three measurements, force was applied smoothly, without jerking, reaching maximum within a 1-2 sec period and held for 5-6 sec. The maximum force was measured by a Baldwin, Lima, Hamilton (BLH)® load cell and displayed on a BLH model 450A transducer indicator. The mean of three trials within 10% of one another was recorded as the isometric strength for each test. Additional trials (to a maximum of five) were performed if one trial exceeded the 10% difference. A 30-sec to 1-minute rest period was provided between trials. Because of technical problems fewer subjects were tested on the lower body apparatus than the other tests.

(3) Leg Power (Vertical Jump). Vertical jump ability was measured using a Vertec® vertical jump meter. The Vertec consisted of a 24" vertical, comb-like array of 48 evenly spaced horizontal vanes. These vanes easily pivoted out of the way when touched. This array was atop a support that allowed positioning from 6' to 12' above the floor. For testing, the subject stood immediately beneath the Vertec with their heels together; he or she reached as far overhead as possible with one hand without lifting either heel off the floor. A technician adjusted the Vertec such that the bottom measurement vane just touched the subject's outstretched hand. The subject was instructed to jump as high as possible and to tap the measurement vanes at the top of their jump with their upward reaching hand. By touching the vanes the subject left a temporary, resettable record of their jump and reach. Because the vanes served as a target for the jumpers, they also served as a motivator to encourage better performance. The subject performed three countermovement jumps. Their maximal jump height was recorded and the measurement vanes reset. A 45 sec rest was given between each jump (55).

(4) Flexibility. A general measure of back and hamstring flexibility was obtained using Wells' sit and reach test (167). Subjects sat on the ground with their legs fully extended and their upper body at a 90° angle to their legs (hip flexion angle of 90°). With fully extended arms, they bent forward as far as possible and pushed on a sliding bar. The distance the subject was able to extend forward (hip flexion) without bending at the knees was measured in reference to a zero point. The zero point was set at the bottom of the feet.

(5) Body Composition. Body composition was measured using three techniques.

(a) The first method was dual energy X-ray absorptiometry (DEXA) (101). The DEXA system (LUNAR®, Madison, WI) was moved, set-up, and calibrated at the test site by a manufacturer's representative. Dressed in shorts and a T-shirt, the volunteer was placed in a supine position on a DEXA scanner table. The body was positioned so the head, trunk, and pelvis were aligned and laterally centered on the table. The hands were rotated palm-downward. Approximately 45 degrees of femoral external rotation was maintained through the placement of VELCRO® straps around the knees and forefeet. Scanning began at the head and progressed in 1-cm slices to the toes with the machine set to the fast 10-min scanning speed. LUNAR software version 3.6 provided estimates of percent body fat and fat-free mass.

(b) The second method of body composition measurement was a skinfold estimate. Skinfolds were obtained from four sites, including the biceps, triceps, subscapular area, and suprailiac area. Three measurements were made at each site by a trained technician using Harpenden® calipers. Percent body fat estimates were obtained using the age and gender adjusted equations of Durnin and Womersley (34).

(c) The third method of body composition measurement was the standard U.S. Army circumference estimate. A Gulik tape was used to measure girths. For men, abdominal and neck girth were measured; for women, hip, forearm, neck, and wrist girth were measured (51). Height and weight were measured with an anthropometer and digital scale, respectively, with the trainee's shoes removed. Percent body fat was estimated from the equations of Vogel et al. (163).

(6) Questionnaire. A questionnaire was administered to subjects who volunteered for the study at the time of the informed Consent Briefing. The questionnaire contained queries on lifestyle characteristics (i.e., tobacco use and physical activity) and past injuries. The questionnaire is at Appendix D.

e. Injury Definitions.

(1) An injury was defined as an event (presumably an energy exchange) that resulted in damage to the body (53) and for which the trainee visited a medical care provider and the encounter was recorded in the medical record. Injuries could be due to overuse (long-term energy exchanges resulting in cumulative microtrauma) or acute trauma (sudden energy exchanges resulting in sudden, overload trauma). Overuse injuries included musculoskeletal pain (not otherwise specified), stress fractures, stress reactions, tendinitis, bursitis, fasciitis, overuse syndromes, and strains. Traumatic injuries included sprains, dislocations, fractures, blisters, abrasions, lacerations, and contusions. Environmental injuries included heat injuries, cold injuries, and insect bites. This latter category was not included in our analysis (i.e., only traumatic and overuse injuries were considered) unless otherwise specified. Stress reactions were defined as musculoskeletal pain for which there was clinical suspicion of a stress fracture but either no X-ray was obtained or the stress fracture could not be diagnosed on the X-ray or bone scan. A stress fracture required X-ray or bone scan confirmation.

(2) A new injury visit (or new injury) was defined as the first visit to a medical care provider for a specific injury. A follow-up injury visit (or follow-up injury) was a subsequent visit to a provider for the same injury. Total injuries included new and follow-up injury visits. A day of limited duty (more commonly called a "profile") was defined as a day in which the medical care provider prescribed a physical limitation for the patient.

(3) Three levels of injury were examined that involved progressively increasing severity. The first level (any injury) included visits to a health care provider for any type of injury. The second level was called a time-loss injury, and it was one that involved one or more days of limited duty. The third level was called a PTRP injury. This was an injury that resulted in the trainee being recommended for the PTRP by the Physical Therapy Clinic of the hospital. In general, a trainee was recommended if they had a physical limitation that would result in missing a week or more of training or if the trainee had been given repeated short-term profiles. It should be noted that these three types of injuries are not mutually exclusive (i.e., less severe injuries include more severe ones).

f. Data Analysis.

(1) Because of findings in past studies, (10, 12, 67, 68, 83, 90) injury incidence was expected to differ considerably between men and women; thus, men and women were analyzed separately. Descriptive statistics (means and standard deviation) were compiled on types of injuries, body location of injuries, limited duty days, demographics, physical characteristics, APFT results, physiological variables, and questionnaire variables. Where comparisons were made among groups on continuous variables (e.g., APFT results, physiological variables, etc.), either a t-test (if only two groups) or analysis of variance (if more than two groups) was used. The specific statistical tests are covered in appropriate sections of the results.

(2) Cumulative injury incidence was calculated as trainees with one or more injuries (numerator) divided by trainees with a medical record (denominator). To examine differences in cumulative incidence between groups, Pearson χ^2 statistic was used to test the hypothesis of no difference.

(3) To examine risk factors for injury, cumulative injury incidence was compared at various levels of each potential risk factor using the Pearson χ^2 statistic to test the hypothesis of no difference between groups. Where appropriate (i.e., where variables were ordinal), Mantel-Hensel χ^2 for trend was employed. Most continuous variables were split into 4 groups of similar size (based on the subject distribution of that variable) and the incidence of injury was compared between quartiles using the chi-square statistic. The continuous physiological variables were split into 3 groups of similar size (tirtiles) to increase statistical power because of the smaller sample size.

(4) Because of the special interest in the FTU, several measures of effectiveness were determined. Injury measures included the three levels of injury discussed above (any injury, time-loss injury, and PTRP injury). Training outcome measures included graduation incidence and discharge incidence. For the analysis, FTU personnel were compared to non-FTU personnel using the Pearson χ^2 statistic to test the hypothesis of no difference in injury risk between the groups.

6. RESULTS.

a. Sample Sizes. The total sample (all trainees in the two battalions) consisted of 1240 individuals. There were 756 men, 474 women, and 10 trainees for whom gender could not be obtained. The cohort (trainees with medical records) consisted of 97% of the male sample and 95% of the female sample. For the sample and each subgroup (FTUs, PTRPs, etc), Table 2 shows the number of basic trainees, the number of trainees with medical records, and the number of missing medical records. Full-cycle trainees were those who started and ended with the battalion. Newstart-ins and newstart-outs include PTRP-in and PTRP-out personnel, respectively. All FTU personnel began training with their respective companies (i.e., they were not newstart-ins). PTRP-ins (and, consequently, newstart-ins) had the largest proportion of missing records. Graduates from the two battalions included 653 men and 350 women.

Table 2. Medical Record Accountability in the Sample and Subgroups

Group or Subgroup	Men				Women			
	Trainees (N)	Medical Records Missing (N)	Medical Records Missing (%)	Trainees With Medical Records (N)	Trainees (N)	Medical Records Missing (N)	Medical Records Missing (%)	Trainees with Medical Records (N)
Sample	756	23	3.0	733	474	22	4.6	452
Cohort	733	0	0	733	452	0	0	452
Full-Cycle	610	6	1.0	604	315	10	3.2	305
FTU	44	0	0	44	95	6	6.3	89
Discharges	102	11	10.8	91	108	3	2.8	105
PTRP-outs	21	1	4.8	20	29	3	10.3	26
PTRP-ins	5	3	60.0	2	10	3	30.0	7
Newstart-outs	37	3	8.1	34	39	6	15.4	33
Newstart-ins	8	3	37.5	5	12	3	30.8	9

b. Physical and Demographic Characteristics.

(1) Table 3 shows the physical characteristics of the cohort. These values were obtained from the physical examination form in the medical record; thus, they reflect the characteristics of the cohort before entry into basic training. BMI was calculated as body mass/stature^2 (82).

Table 3. Physical Characteristics of the Cohort

Characteristic	Men			Women		
	N	Mean	SD	N	Mean	SD
Age (yrs)	729	21.5	3.6	449	21.3	3.8
Stature (cm)	731	176.0	7.5	448	164.3	6.5
Body Mass (kg)	731	75.3	13.3	448	62.2	10.6
BMI (kg/m^2)	731	24.2	3.8	448	23.0	3.2

(2) Table 4 shows the demographic characteristics of the cohort obtained primarily from the MTS. The majority of the cohort were E-1's, white, single, and high school graduates.

Table 4. Demographic Characteristics of the Cohort

Characteristic	Level of Characteristic	Men		Women	
		N	Proportion of Total (%)	N	Proportion of Total (%)
Rank	E-1	482	65.8	267	59.1
	E-2	117	16.0	72	15.9
	E-3	72	9.8	52	11.5
	E-4	31	4.2	16	3.5
	Unknown/Missing	31	4.2	45	10.0
Ethnicity	White	447	61.0	210	46.5
	Black	180	24.6	170	37.6
	Hispanic	44	6.0	30	6.6
	Other	30	4.1	14	3.1
	Unknown/Missing	32	4.2	26	5.8
Component	Regular Army	460	62.8	277	61.3
	National Guard	143	19.5	61	13.5
	Reserves	98	13.4	69	15.3
	Unknown/Missing	32	4.4	45	10.0
Education	< High School	2	0.3	0	0
	GED	168	22.9	37	8.2
	High School Grad	453	61.8	299	66.2
	1-3 Yrs College	41	5.6	43	9.5
	College Grad	27	3.7	15	3.3
	Unknown/Missing	42	5.7	58	12.8
Marital Status	Single	546	74.5	292	64.6
	Married	129	17.6	76	16.8
	Divorced	10	1.4	20	4.4
	Unknown/Missing	48	6.5	64	14.2

c. General Description of Injuries in the Cohort and Subgroups.

(1) Table 5 shows the cumulative injury incidence statistics for the cohort and various subgroups. Gender differences were apparent. Injury incidence in all three categories (any injury, time-loss injury, or PTRP injury) was higher in the women than in the men in the cohort ($p<0.01$) and in newstart-outs ($p<0.01$). In full-cycle trainees, women had a greater incidence of any injury and time-loss injuries ($p<0.01$). There were no significant gender differences among FTU, discharges, or newstart-ins for any injury or time-loss injuries ($p<0.10$). Female discharges had a larger likelihood of a PTRP injury than the male discharges ($p=0.09$)

(2) The overall impact of injuries on trainees who did not complete basic training can be appreciated by comparing full-cycle trainees to those who were nonfull-cycle (discharges and newstarts). The incidence of any injury for men was 30.8% and 65.9% for full-cycle and nonfull-cycle trainees, respectively ($p<0.01$). For women, the incidence of any injury was 58.0% and 73.5% for full-cycle and nonfull-cycle trainees, respectively ($p<0.01$). The incidence of time-loss injury for male full-cycle and nonfull-cycle trainees were 22.2% and 58.1%, respectively ($p<0.01$); for women, time-loss injury incidence was 48.5% and 66.7%, respectively ($p<0.01$). Obviously, no full-cycle trainee suffered a PTRP injury.

(3) There was an increase in women's injury risk, relative to men, as the seriousness of the injury increased. Women's risk of injury relative to men (risk ratio=women/men) increased from 1.7 to 1.9 to 2.5 for any injury, time-loss injury, and PTRP injury, respectively. For full-cycle trainees, these ratios were 1.9 and 2.2 for any injury and time-loss injury, respectively (there were no PTRP injuries in full-cycle trainees).

Table 5. Cumulative Injury Incidence (8 Weeks) in the Cohort and Subgroups

	Men				Women			
Group or Subgroup	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)
Cohort	733	37.0	28.5	4.8	452	63.1	54.4	11.9
Full-Cycle	604	30.8	22.2	0	305	58.0	48.5	0
FTU	44	56.8	50.0	9.1	89	61.8	53.9	16.9
Discharges	91	65.9	58.2	16.5	105	66.7	59.0	26.7
Newstart-outs	34	64.7	58.8	58.8	33	97.0	93.9	81.8
Newstart-ins	5	100.0	80.0	0	9	88.9	77.8	0

(4) Table 6 shows the number of injuries and limited duty days in the cohort and subgroups. The number of limited duty days per cohort trainee was 2.2 and 5.4 for men and women, respectively. Among the subgroups, full-cycle trainees had the fewest number of limited duty days per trainee, 1.0 for men and 2.7 for women.

(5) The number of limited duty days was considerably less for full-cycle trainees than for individuals who did not start and finish with the battalion (mainly discharges and newstarts). Male full-cycle trainees were 82% of the cohort but accounted for only 39% of limited duty days. Female full-cycle trainees were 67% of the cohort but accounted for only 34% of the limited duty days. Thus, the 18% of men and 33% of women who were nonfull-cycle (i.e., discharges and newstarts) accounted for 61% and 66% of the limited duty days, respectively.

Table 6. Number of Injuries and Limited Duty Days in the Cohort and Subgroups

	Men				Women			
Group or Subgroup	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)	Total (N)	New Injuries (N)	Total Injuries	Limited Duty Days
Cohort	733	332	494	1606	452	373	613	2421
Full-Cycle	604	232	292	623	305	246	334	827
FTU	44	30	51	142	89	76	117	506
Discharges	91	73	140	535	105	76	154	919
Newstart-outs	34	26	60	445	33	46	99	660
Newstart-ins	5	4	6	5	9	7	34	83

d. Injury Distribution in the Cohort.

(1) The distribution of new injury visits in the cohort by diagnosis is shown in Table 7. Overuse injuries accounted for 75% of male new injuries and 78% of female injuries. Musculoskeletal pain (not otherwise specified) accounted for 41% of the male new injuries and 40% of the female injuries. Strains and sprains accounted for 10%

and 9%, respectively, of the male new injury visits, and 7% and 10%, respectively, of the female visits. Overall incidence of stress fractures (individuals with one or more) was 1.4% for men and 4.4% for women. The overall incidence of stress fractures plus stress reactions was 2.7% for men and 9.3% for women.

Table 7. Distribution of Injuries in the Cohort by Diagnosis

Category of Injury	Type of Injury	Men (N=733) New Injury Visits (N)	Men (N=733) Total Injury Visits (N)	Men (N=733) Limited Duty Days (N)	Women (N=452) New Injury Visits (N)	Women (N=452) Total Injury Visits (N)	Women (N=452) Limited Duty Days (N)
OVERUSE	Pain	135	171	500	151	197	652
	Strains	34	50	100	27	46	207
	Stress Fractures	10	25	153	16	51	259
	Stress Reactions	9	18	123	21	50	383
	RPPS[a]	11	21	70	11	21	67
	Tendinitis/Fasciitis	17	21	59	19	27	118
	Overuse (NOS[b])	32	61	223	47	93	427
TRAUMATIC	Sprain	30	55	218	38	68	188
	Blisters	11	15	15	22	22	16
	Contusions	10	10	13	7	10	18
	Abrasions/Lacerations	7	10	6	4	11	21
	Fractures	5	12	63	4	7	51
	Dislocations	2	4	49	0	0	0
	Other Traumatic	19	21	14	6	10	14
Total		332	494	1606	373	613	2421

[a]RPPS = Retroplatellar pain syndrome
[b]NOS = Not otherwise specified

(2) Overuse injuries accounted for 76% of male limited duty days and 87% of female limited duty days. Profiles recorded in the medical record for which days of limited duty were not listed accounted for 14.8% of all male total visits and 14.5% of all female total visits.

(3) In addition to overuse and traumatic injuries, there were a number of environmental injuries. These included13 heat-associated injuries, 24 insect bites, and 5 injuries involving other environmental-associated problems (new injury visits). The heat-associated injuries accounted for 9 limited duty days and animal bites accounted for 6 limited duty days.

Table 8. Distribution of Injuries in the Cohort by Body Part

Body Area	Body Part	Men (N=733) New Injury Visit (N)	Men Total Injury Visits (N)	Men Limited Duty Days (N)	Women (N=452) New Injury Visits (N)	Women Total Injury Visits (N)	Women Limited Duty Days (N)
UPPER BODY	Head/Face	2	3	0	1	2	3
	Neck	3	3	3	2	3	8
	Chest	7	8	15	8	11	26
	Abdomen	1	1	3	3	6	20
	Upper Back	4	6	6	3	5	9
	Shoulders	12	20	44	12	20	66
	Arms/Elbows	4	8	17	2	2	5
	Wrist	5	7	25	5	7	24
	Hand	10	14	94	4	11	23
	Fingers	5	5	0	4	6	12
LOWER BODY	Lower Back	38	61	196	27	40	196
	Pelvis/Hips	8	10	39	11	22	83
	Thigh	13	20	50	15	22	70
	Knee	69	112	422	71	115	455
	Calf	4	6	15	3	3	9
	Shin	27	45	187	38	64	342
	Ankle	52	75	226	76	137	626
	Foot	48	63	200	76	118	394
	Toe	18	19	17	7	10	8
	Unknown/Multiple	2	8	47	5	9	42
	Total	332	494	1606	373	613	2421

(4) Table 8 shows the distribution of injuries by body part. Most of the injuries involved the lower body, especially the knee and below. The lower body was involved in 83% of the male new injury visits and 87% of the female visits. The most common injury sites were: the knee, accounting for 21% of male new visits and 19% of female visits, the ankle, accounting for 16% of male new injury visits and 20% of female visits, and the foot accounting for 14% of male new injury visits and 20% of female visits. In all, new injury visits involving the knee and lower body accounted for 66% of the male new injury visits and 73% of the female new injury visits. Upper body injuries accounted for 16% of the male new injury visits and 12% of the female new injury visits. Lower body injuries accounted for 84% of male limited duty days and 90% of female limited duty days. Upper body injuries accounted for 13% of the male limited duty days and 8% of the female limited duty days.

(5) To calculate injury rates by week of training, weekly denominators for the cohort were obtained from the unit status reports. Table 9 shows injuries by week of training, and Figure 1 shows these same data graphically. For both men and women, injury rates peaked in the third week of training and progressively declined after this.

Table 9. Injury Rates by Week for the Cohort

Week	Men (%)	Women (%)
1	6.6	12.1
2	8.4	15.7
3	10.7	16.1
4	6.0	13.3
5	3.9	11.6
6	4.5	9.2
7	2.6	5.0
8	3.9	5.4

(6) Limited duty days by week are displayed in Table 10 and shown graphically in Figure 2. The pattern is similar to that seen in injury rates (Figure 1). For men, limited duty days peaked in week 3, then declined rapidly in weeks 4 to 5 and remain at a low level. For women, there is a peak in week 2 and little change in week 3. Limited duty days declined in week 4, but there is little change subsequently until after week 6 when limited duty days dropped sharply.

Table 10. Limited Duty Days by Week for the Cohort

Week	Men (N)	Women (N)
1	213	348
2	313	510
3	502	479
4	322	325
5	74	305
6	86	274
7	24	93
8	73	87

Figure 1. Injury Rate in Cohort by Week of Training

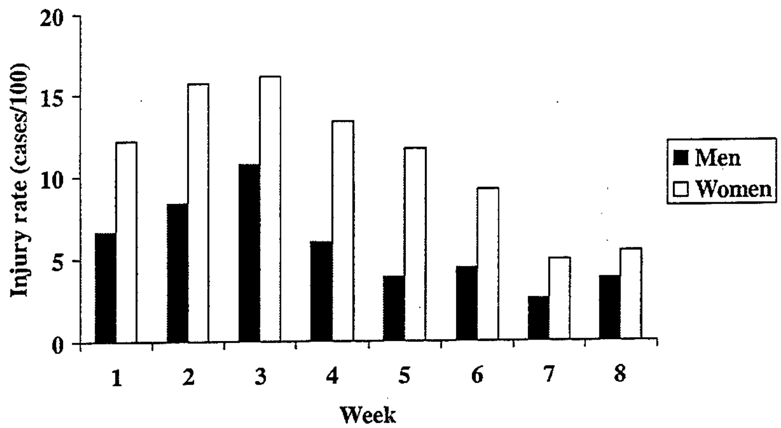
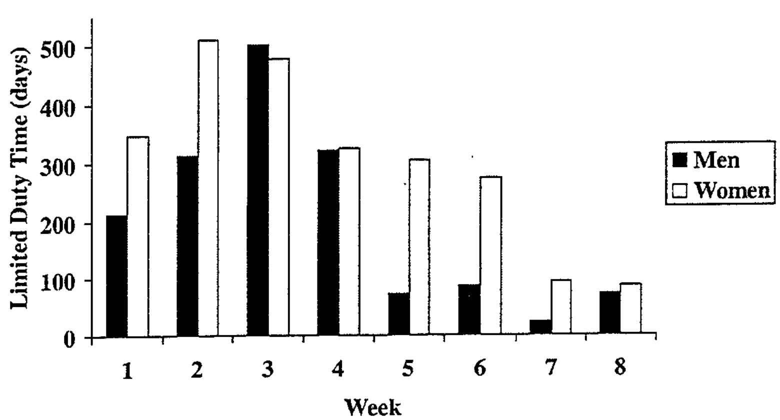


Figure 2. Limited Duty Days by Week of Training in the Cohort



e. APFT Data of the Cohort. Table 11 shows the first diagnostic and final APFT results for that portion of the cohort that completed both tests. Male improvements on push-ups, sit-ups, and 2-mile run were 47%, 38%, and 17%, respectively. Female improvements on push-ups, sit-ups, and 2-mile run were 139%, 57%, and 17%, respectively.

Table 11. APFT Performance of the Cohort

	Men			Women		
	Diagnostic (Mean±SD)	Final (Mean±SD)	Change (Final-Diagnostic)	Diagnostic (Mean±SD)	Final (Mean±SD)	Change (Final-Diagnostic)
Push-ups (reps)	32.2+14.3	47.4+12.7	15.2	10.6+10.0	25.3+10.0	14.7
Sit-ups (reps)	40.8+13.3	56.5+9.7	15.7	34.6+15.4	54.3+11.9	19.7
2-Mile Run (min)	17.5+2.9	14.6+1.6	-2.9	21.5+3.0	17.8+1.6	-3.7

f. Fitness Training Unit Personnel.

(1) Injuries Among FTU Trainees.

(a) Table 12 shows injury incidence among FTU personnel. FTU men were more likely to suffer an injury (any injury) than men who were non-FTU both in the cohort ($p<0.01$) and among full-cycle trainees ($p=0.04$). FTU men were more likely to suffer a time-loss injury both within the cohort ($p<0.01$) and among the full-cycle men ($p=0.07$). This was not the case for the women. Both FTU and non-FTU women were equally likely to get injured among cohort ($p=0.78$) and full-cycle women ($p=0.88$). Time-loss injury incident was also similar among FTU and non-FTU women for the cohort ($p=0.92$) and for full-cycle trainees ($p=0.92$).

(b) In our sample, FTU men and women were no more likely to suffer a PTRP injury than trainees who were non-FTU ($p=0.17$ for men and $p=0.11$ for women). However, the sample of those entering the PTRP was small and there were strong trends in the data suggesting the FTU trainees were injured more often. We obtained PTRP data from nine other battalions that had BCT cycles running from 9 January to 21 May 98. These data are shown in Table 13. Note that the trends are similar to those of Table 12, and that both men and women who came from the FTU were more likely to suffer a PTRP injury.

Table 12. Cumulative Injury Incidence (8 Weeks) in the FTU Personnel and Others

Group or Subgroup	Men				Women			
	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)
FTU (Cohort)	44	56.8	50.0	9.1	89	61.8	53.9	16.9
Full-Cycle FTU	24	50.0	37.5	0	56	58.9	50.0	0
Nonfull-Cycle FTU	20	65.0	65.0	20.0	33	66.7	60.6	45.5
Non-FTU	689	35.7	27.1	4.5	363	63.4	54.5	10.7

Table 13. Comparison of FTU and Non-FTU Trainees Sent to the PTRP (From 9 Battalions)

	Men			Women		
	N	PTRP Injury (%)	Chi-Square p-value	N	PTRP Injury (%)	Chi-Square p-value
FTU	233	9.0	<0.01	554	14.0	<0.01
Not FTU	3801	2.7		2079	10.0	

(c) Table 14 shows the total number of injuries and limited duty days among the FTU personnel. Men and women who were non-FTU had 2.1 and 5.3 days of limited duty per trainee, respectively. Men and women who were from the FTU had 3.2 and 5.6 days of limited duty per trainee, respectively. FTU personnel who did not complete the cycle accounted for most of these limited duty days, 3.9 and 11.3 days per trainee for men and women, respectively.

Table 14. Number of Injuries and Limited Duty Days Among FTU Trainees and Others

Group or Subgroup	Men				Women			
	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)
FTU	44	30	51	142	89	76	117	506
Full-Cycle FTU	24	15	24	65	56	45	56	131
Nonfull-Cycle FTU	20	15	27	77	33	31	61	375
Non-FTU	689	302	443	1464	363	297	496	1915

(2) APFT Data of FTU Personnel.

(a) Table 15 shows the first diagnostic APFT results for FTU men and women compared to those who were non-FTU. An independent sample t-test was used for the statistical comparison. As expected, the performance of FTU trainees was lower than that of non-FTU trainees. Exceptions were the men's sit-ups and women's 2-mile run where performance did not significantly differ between the two groups.

Table 15. Comparison of FTU and Non-FTU Personnel on First Diagnostic APFT Performance

Event	Group	Men				Women			
		N	Mean (reps or min)	SD (reps or min)	p-value[a]	N	Mean (reps or min)	SD (reps or min)	p-value[a]
Push-ups	FTU	36	23.0	13.0	<0.01	81	8.4	8.8	0.03
	Non-FTU	654	32.8	14.2		312	11.2	10.2	
Sit-ups	FTU	36	38.2	15.6	0.24	81	30.0	15.1	<0.01
	Non-FTU	651	40.8	13.2		311	35.8	15.2	
Run	FTU	36	20.3	3.2	<0.01	80	21.6	2.7	0.86
	Non-FTU	649	17.3	2.8		308	21.5	3.0	

[a]From independent sample t-test

(b) Table 16 shows a comparison of the first diagnostic and final (record) APFT results for FTU and non-FTU trainees. A two-way mixed model analysis of variance was used for this comparison (independent groups, repeated measures on the diagnostic and final APFT). This analysis includes only those who completed both tests. All groups improved significantly on all events from the first diagnostic to the record test. The non-FTU group demonstrated higher performance than the FTU group on all APFT events, except for the female 2-mile run times. On push-ups and sit-ups there were no significant interactions indicating improvements in the two groups were similar. However, there was a significant interaction for the run among both men and women. For the men, the interaction in the run data indicated that the FTU group improved relatively more than the non-FTU group. For the women, the interaction indicated the opposite, that the FTU women did not improve as much as non-FTU women

Table 16. Comparison of FTU and Non-FTU Personnel on First Diagnostic and Final APFT

				Diagnostic		Final		p-values[a]		
Gender	Event	Group	N	Mean (reps or min)	SD (reps or min)	Mean (reps or min)	SD (reps or min)	FTU vs Non-FTU	Diag vs Final	Interaction
MEN	Push-up	FTU	29	23.7	12.9	37.7	13.0	<0.01	<0.01	0.80
		Non-FTU	590	33.6	14.1	48.2	12.3			
	Sit-up	FTU	29	38.8	14.4	51.7	10.9	0.05	<0.01	0.23
		Non-FTU	588	41.5	13.2	56.8	9.6			
	Run	FTU	26	20.1	3.4	16.4	2.0	<0.01	<0.01	0.04
		Non-FTU	568	17.2	2.8	14.5	1.4			
WOMEN	Push-up	FTU	61	9.3	9.3	21.8	8.1	<0.01	<0.01	0.15
		Non-FTU	258	11.9	10.4	26.2	10.2			
	Sit-up	FTU	59	31.1	15.9	46.5	12.1	<0.01	<0.01	0.13
		Non-FTU	245	37.1	15.4	56.2	11.2			
	Run	FTU	57	21.2	2.5	18.4	1.7	0.19	<0.01	0.01
		Non-FTU	237	21.2	2.8	17.7	1.5			

[a] From two-way mixed model analysis of variance

(3) Training Outcomes Among FTU Personnel.

(a) Table 17 shows a comparison of training outcomes between personnel who came from the FTU and those who did not. This analysis includes the entire sample, not just the cohort. Men coming from the FTU were less likely to complete the cycle and more likely to be discharged. When specific reasons for discharge were examined, FTU men were more likely to be a ELS discharge (Chapter 11) or a medical discharge (refused PTRP and medical conditions that existed prior to service combined).

Table 17. Training Outcomes Among FTU Trainees and Non-FTU Trainees

Outcome	Group	Men			Women		
		N	Proportion in Category (%)	Chi-Square p-value	N	Proportion in Category (%)	Chi-Square p-value
Full-Cycle	FTU	44	54.5	<0.01	95	60.0	0.14
	Non-FTU	712	82.3		379	68.1	
Discharged	FTU	44	27.3	<0.01	95	23.2	0.92
	Non-FTU	712	12.6		379	22.7	
Discharged (ELS[a])	FTU	44	27.3	<0.01	95	23.2	0.92
	Non-FTU	712	12.6		379	22.7	
Discharged (Refused PTRP)	FTU	44	4.5	0.21	95	5.3	0.77
	Non-FTU	712	1.8		379	6.1	
Discharged (EPTS[b])	FTU	44	6.8	0.16	95	8.4	0.47
	Non-FTU	712	2.9		379	6.3	
Discharged (Refused PTRP or EPTS[b])	FTU	44	11.4	0.06	95	13.7	0.73
	Non-FTU	712	4.8		379	12.4	

[a]ELS = Entry Level Separation (Chapter 11)
[b]EPTS = Medical condition that existed prior to service

(b) Compared to the men, women presented a considerably different picture. Both FTU and non-FTU women had a similar likelihood of completing the cycle and of being discharged for any reason. Even when specific reasons for discharge were examined, there was no difference between FTU and non-FTU women.

g. Discharges.

(1) Number of Discharges.

(a) Table 18 shows the number of trainees discharged in the sample and the reasons for discharge. Most of the discharges were of the ELS type (Chapter 11) accounting for 75% of male discharges and 68% of female discharges. The second largest discharge category was for EPTS (medical) accounting for 24% of male and 30% of female discharges. There were 15 men and 28 women who were discharged under Chapter 11 for declining to go to the PTRP (15% and 26% of the male and female discharges, respectively).

Table 18. Number of Trainees Discharged and Reasons for Discharge

Discharge Reason	Men	Women	Gender Unknown
ELS[a]	77	73	2
EPTS[b]	24	32	0
Homosexuality	0	3	0
Misconduct	1	0	0
All Reasons	102	108	2

[a]ELS = Entry level separation (Chapter 11)
[b]EPTS = Medical condition that existed prior to service

(b) In order to determine the proportion of trainees discharged for all medical reasons, EPTS and PTRP refusals were combined. This category accounted for 38% of male discharges and 56% of female discharges. When looked at as part of the entire sample, the proportion of trainees discharged for medical reasons was 5.2% of the men (39 discharges/756 men) and 12.7% of the women (60 discharges/474 women).

(2) Injuries Among Discharged Trainees.

(a) Table 19 shows injury incidence for discharges and various discharge reasons. For men, discharges were more likely to be injured than individuals not discharged ($p<0.01$ for both any injury and time-loss injury). This was true regardless of the reason for discharge: men who were EPTS discharges, ELS discharges, or ELS discharges excluding PTRP refusals were all more likely to be injured than trainees who were not discharged ($p<0.02$).

(b) On the other hand, women who were discharged were no more likely to be injured than women who were not discharged ($p=0.38$ for any injury, $p=0.43$ for time-loss injury). This was true regardless of the reason for the discharge. Equally likely to be injured when compared to trainees who were not discharged were female trainees who were:

1. Medical discharges ($p=0.94$ any injury, $p=0.37$ for time-loss injury),

2. ELS discharges ($p=0.26$ for any injury, $p=0.89$ for time-loss injury), or

3. ELS discharges excluding PTRP refusals ($p=0.28$ for any injury, $p=0.17$ for time-loss injury).

Table 19. Injury Incidence in Discharged Trainees and Others

Group or Subgroup	Men				Women			
	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)
Discharge	91	65.9	58.2	16.5	105	66.7	59.0	26.7
EPTS[a] Discharge	23	78.3	73.9	0	31	61.3	54.8	0
Non-EPTS[a] Discharge	68	61.8	52.8	22.1	74	68.9	60.8	37.8
ELS[b] Discharge	67	61.2	52.2	22.4	71	69.0	52.2	39.4
ELS[b] Discharge (without PTRP Refusals)	52	52.0	38.5	0	43	53.5	41.9	0
ELS[b] Discharge (PTRP Refusals)	15	100.0	100.0	100.0	28	100.0	100.0	100.0
Not Discharged	642	32.9	24.3	3.1	347	62.0	53.0	7.5

[a]EPTS = Medical condition that existed prior to service
[b]ELS = Entry level separation (Chapter 11)

(c) PTRP injury incidence was higher among men who were discharged (<0.01) and women who were discharged ($p<0.01$) compared to those who were not discharged. However, this was primarily because many of the discharges were for PTRP refusals.

(d) Table 20 shows the number of injuries and limited duty days experienced by the discharges. Men had 5.9 and 1.7 days of limited duty for those discharged and those not discharged, respectively. Women had 8.8 and 4.3 days of limited duty for those discharged and those not discharged, respectively. Male and female ELS discharges for PTRP refusals accounted for the largest number of limited duty days per trainee, 18.5 and 20.1 for men and women, respectively.

Table 20. Total Number of Injuries and Limited Duty Days among Types of Discharges

Group or Subgroup	Men				Women			
	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)
Discharge	91	73	140	535	105	76	154	929
EPTS[a] Discharge	23	17	34	24	31	17	35	270
Non-EPTS[a] Discharge	68	56	106	451	74	59	119	649
ELS[b] Discharge	67	55	105	448	71	57	115	637
ELS[b] Discharge (without PTRP Refusals)	52	37	64	170	43	25	34	74
ELS[b] Discharge (Refused PTRP)	15	18	41	278	28	32	81	563
Not Discharged	642	258	353	1071	347	297	459	1492

[a]EPTS = Medical condition that existed prior to service
[b]ELS = Entry level separation (Chapter 11)

(e) Discharges obviously did not complete the entire 56-day (8 week) training cycle. For men, the average(SD) amount of time male trainees were in the battalion until discharge was 31.7 (14.0) days; for women the time was 30.3 (13.1) days. This averages just slightly more than 1/2 the training cycle (57% of the cycle for men and 54% of the cycle for women). A person-time analysis of the discharge injuries is at Appendix E, and results are similar to the injury incidence analysis above.

(3) APFT Data and Physical Characteristics of Discharged Trainees.

(a) Table 21 shows first diagnostic APFT results of individuals who were discharged versus those who were not. Discharged individuals had lower APFT performance on all events.

Table 21. First Diagnostic APFT Results of Discharged Trainees Compared to Trainees Not Discharged

Gender	Event	Status	N	Mean (reps or min)	SD (reps or min)	Difference Between Discharged and Not Discharged (reps or min)	p-value[a]
MEN	Push-up	Discharged	68	25.2	13.0	7.8	<0.01
		Not Discharged	622	33.0	14.2		
	Sit-up	Discharged	67	36.5	12.4	4.7	<0.01
		Not Discharged	620	41.2	13.3		
	Run	Discharged	70	18.1	3.1	0.7	0.07
		Not Discharged	615	17.4	2.9		
WOMEN	Push-up	Discharged	66	7.6	9.3	3.5	<0.01
		Not Discharged	327	11.1	10.0		
	Sit-up	Discharged	66	29.9	12.5	5.6	<0.01
		Not Discharged	326	35.5	15.7		
	Run	Discharged	69	22.9	3.7	1.7	<0.01
		Not Discharged	319	21.2	2.7		

[a]Independent sample t-test comparing discharged and not discharged

(b) Table 22 shows a comparison of the physical characteristics of trainees who were discharged and those who were not. The discharged men were slightly shorter in stature than those not discharged. The discharged women were slightly older, had more body mass, and had a greater BMI.

Table 22. Comparison of Physical Characteristics of Discharged and Others

Gender	Characteristic	N	Discharged (Mean (SD))	N	Not Discharged (Mean(SD))	p-Value[a]
MEN	Age (yrs)	90	21.1(3.6)	639	21.5(3.6)	0.35
	Stature (cm)	90	174.8(6.7)	641	176.3(7.2)	0.03
	Body Mass (kg)	90	73.6(13.4)	641	75.6(13.3)	0.19
	BMI (kg/m^2)	90	24.1(3.8)	641	24.2(3.8)	0.77
WOMEN	Age (yrs)	104	20.8(3.2)	345	21.5(3.9)	0.09
	Stature (cm)	101	165.0(7.4)	347	165.0(6.2)	0.14
	Body Mass (kg)	101	64.4(12.5)	347	61.5(10.0)	0.02
	BMI (kg/m^2)	101	23.5(3.4)	346	22.8(3.1)	0.07

[a]Independent sample t-test comparing discharged and not discharged

h. Newstart-Outs. There were 76 newstart-outs. Of these, 50 (66%) went to the PTRP, 12 (16%) were APFT failures, 9 (12%) were basic rifle marksmanship failures, 3 (4%) were for missing too much training, and 2 (3%) were personnel returned to the FTU.

(1) Injuries Among Newstart-Outs.

(a) Table 23 shows the injury incidence in the newstart-outs. Among the men, injuries were more likely among trainees who were newstart-outs compared to those who were not newstart-outs (p<0.01). This was due primarily to PTRP-outs. When newstarts who were not PTRP-outs were compared to trainees who were not newstarts, the injury incidence was similar (p=0.44 for any injury, p=0.29 for time-loss injury).

Table 23. Injury Incidence in Newstart-Outs and Others

	Men				Women			
Group or Subgroup	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)	Total (N)	Any Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)
Newstart-out	34	64.7	58.8	58.8	33	97.0	93.9	81.8
PTRP-out	20	90.0*	90.0*	100.0	26	100.0	100.0	100.0
Newstart-out Not PTRP-out	14	21.4	14.3	0	7	85.7	71.4	0
Not Newstart-out	699	35.8	27.0	2.1	419	60.4	51.3	6.4

* Two individuals were injured in the Reception Station, not BCT

(b) Among women, injuries were more likely among trainees who were newstart-outs compared to those who were not newstart-outs (p<0.01). Despite the fact that injury incidence appeared higher in newstart-outs who were not PTRP, the sample size was small and did not yield a significant difference when this group was compared to those who were not newstart-outs (p=0.17 for any injury, p=0.29 for time-loss injury).

(c) Table 24 shows the number of injuries and limited duty days experienced by the newstart-outs. Men and women who were not newstart-outs had 1.7 and 4.2 days of limited duty per trainee, respectively. Male and female newstart-outs had 13.1 and 20.0 days of limited duty per trainee, respectively. The PTRP-outs had most of the limited duty days. Male and female PTRP-outs had 21.2 and 22.4 days of limited duty per trainee, respectively. Men and women who were not PTRP-outs (but still newstarts) had 1.6 and 11.0 days of limited duty per trainee (men and women, respectively).

Table 24. Number of Injuries, and Limited Duty Days in Newstart-Outs and Others

Group or Subgroup	Men				Women			
	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)
Newstart-outs	34	26	60	445	33	46	99	660
PTRP-out	20	21	52	423	26	37	68	583
Newstart-out, not PTRP	14	5	8	22	7	9	14	77
Not Newstart-out	699	306	434	1160	419	327	514	1761

(d) We were unable to obtain time-in-unit data on all newstart-outs, but were able to obtain these data on most PTRP-outs. The average number of days PTRP-outs were in the battalions were similar to that of the discharges. For men, the average±SD time in training was 30.7±11.6 days; for women, the average time was identical, 30.7±12.2 days. These averages are just slightly more than half the training cycle (55% of the cycle for both men and women). An incidence rate analysis of injuries among PTRP-outs is at Appendix E. Results are similar to the injury incidence data presented in this section.

(2) APFT Data of Newstart-Outs.

(a) Table 25 shows the first diagnostic APFT results of newstart-outs compared to those who were not newstart-outs. An independent sample t-test was used for this analysis. On all events, newstart-outs had lower performance levels.

Table 25. Comparison of APFT Results between Newstart-Outs and Others

Gender	Event	Status	N	Mean (reps or min)	SD (reps or min)	Difference[a] (reps or min)	p-value[b]
MEN	Push-up	Newstart-outs	29	22.6	10.6	10.1	<0.01
		Not Newstart-outs	661	32.7	14.3		
	Sit-up	Newstart-outs	29	34.8	15.1	6.2	0.01
		Not Newstart-outs	658	41.0	13.2		
	Run	Newstart-outs	28	19.4	3.7	2.0	<0.01
		Not Newstart-outs	657	17.4	2.8		
WOMEN	Push-up	Newstart-outs	25	6.8	7.3	4.1	0.05
		Not Newstart-outs	368	10.9	10.1		
	Sit-up	Newstart-outs	25	25.1	14.8	10.1	<0.01
		Not Newstart-outs	367	35.2	15.2		
	Run	Newstart-outs	28	22.8	2.2	1.4	0.02
		Not Newstart-outs	360	21.4	3.0		

[a]Calculated as Not Newstart-out minus Newstart-out
[b]Independent sample t-test comparing Newstart-outs to not newstart-outs

(b) Table 26 shows a further breakdown of the newstart-outs including those sent to PTRP and those newstarted for other reasons. A one-way analysis of variance (ANOVA) was used for this comparison and a Tukey test was used to determine differences between groups. Men who were either PTRP-outs or newstarted for other reasons had lower performance on push-ups and the run compared to trainees who were not newstarts. Male newstarts who were not PTRP-outs had lower performance on the sit-ups than those who were not newstart-outs. Among the women, PTRP-outs had lower performance on the run but not on any other APFT event. Women who were newstarts but not PTRP-outs had lower sit-up performance than women who were not newstart-outs. The sample size for female newstart-outs who were not PTRP was very small.

Table 26. Comparison of Newstart-Outs and Others on APFT Results

Gender	Event	Status	N	Mean	SD	One-Way ANOVA[a] p-value	Tukey Test Results[b]
MEN	Push-up	PTRP-outs	15	20.8	10.3	<0.01	<0.01
		Newstarts, Not PTRP-outs	14	24.6	11.1		0.03
		Not Newstart-outs	661	32.7	14.3		
	Sit-up	PTRP-outs	15	38.3	14.8	0.02	0.54
		Newstarts Not PTRP-outs	14	31.1	15.0		0.02
		Not Newstart-outs	658	41.0	13.2		
	Run	PTRP-outs	14	19.4	3.8	<0.01	0.03
		Newstarts Not PTRP-outs	14	19.4	3.8		0.03
		Not Newstart-outs	657	17.4	2.8		
WOMEN	Push-up	PTRP-outs	19	7.3	6.8	0.12	---
		Newstarts Not PTRP-outs	6	5.0	9.3		
		Not Newstart-outs	368	10.9	10.1		
	Sit-up	PTRP-outs	19	28.4	13.5	<0.01	0.12
		Newstarts Not PTRP-outs	6	14.8	15.2		<0.01
		Not Newstart-outs	367	35.2	15.2		
	Run	PTRP-Outs	21	22.7	2.3	0.05	0.05
		Newstarts Not PTRP-outs	7	23.3	2.2		0.12
		Not Newstart-outs	360	21.4	3.0		

[a]ANOVA=analysis of variance

[b]The first number represents the p-value of the Tukey Test comparison of not newstart-outs to PTRP-outs; the second number represents the p-value of the Tukey Test comparison of not newstart-outs to newstarts who were not PTRP-outs

i. Newstart-Ins. Descriptive statistics on injuries among newstart-ins are presented in Tables 27 and 28. None of the newstart-ins suffered a PTRP injury. However, of the 21 newstart-ins, medical records were obtained on only 14 (67%). Because of the small sample size and missing medical records, no further analysis of these data was undertaken.

Table 27. Injury Incidence Among Newstart-Ins and Others

Group or Subgroup	Men				Women			
	Total (N)	Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)	Total (N)	Injury Incidence (%)	Time-loss Injury Incidence (%)	PTRP Incidence (%)
Newstart-ins	5	100.0	80.0	0	9	88.9	77.8	0
PTRP-ins	2	100.0	100.0	0	7	85.7	71.4	0
Newstart-ins Not PTRP-out	3	100.0	66.7	0	2	100.0	100.0	0
Not Newstart-ins	728	36.5	28.2	4.8	366	62.5	54.0	12.2

Table 28. Number of Injuries and Limited Duty Days Among Newstart-ins and Others

Group or Subgroup	Men				Women			
	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)	Total (N)	New Injuries (N)	Total Injuries (N)	Limited Duty Days (N)
Newstart-ins	5	4	6	5	9	7	34	83
PTRP-ins	2	2	3	3	7	5	27	55
Newstart-ins Not PTRP	3	2	2	3	2	2	8	18
Not Newstart-ins	728	328	488	1601	443	366	579	2338

j. Physiological Measures.

(1) There were 336 trainees in the cohort who performed the physiological tests (N=170 men and 166 women). Table 29 shows a comparison of these trainees with those who did not perform the physiological tests. Age, stature, and body mass were obtained from the medical records; the APFT data was obtained from the first diagnostic test. Men in the physiological group were slightly taller (0.5 cm) and

performed more push-ups. Women in the physiological group had slightly less average body mass (2.5 kg) and a lower BMI. In general, there were small mean differences (and variances) between the physiological subjects and those who were not, suggesting the physiological subjects were representative of the cohort, at least on these measures.

Table 29. Comparison of Trainees in Physiological Sample and Those Not in the Physiological Sample (cohort only)

Variable[a]	Group[b]	Men				Women			
		N	Mean	SD	p-value[c]	N	Mean	SD	p-value[c]
Age (yrs)	Phy	169	21.7	3.4	0.36	166	21.3	3.4	0.86
	Not Phy	560	21.4	3.6		283	21.4	4.0	
Height (cm)	Phy	169	177.3	7.4	0.03	165	163.8	6.1	0.20
	Not Phy	562	176.8	7.6		283	164.6	6.6	
Body Mass (kg)	Phy	169	76.7	13.0	0.13	165	60.6	9.9	0.02
	Not Phy	562	74.9	13.4		283	63.1	11.0	
BMI (kg/m^2)	Phy	169	24.4	3.7	0.58	164	22.5	3.0	0.03
	Not Phy	562	24.1	3.9		283	23.2	3.3	
First Diagnostic Push-ups (reps)	Phy	165	35.6	13.3	<0.01	149	11.4	9.8	0.23
	Not Phy	527	31.2	14.4		244	10.1	10.0	
First Diagnostic Sit-Ups (reps)	Phy	163	42.0	13.1	0.16	149	35.5	15.4	0.35
	Not Phy	524	40.4	13.4		243	34.0	15.4	
First Diagnostic 2-Mile Run (min)	Phy	164	17.2	3.0	0.21	143	21.4	3.1	0.44
	Not Phy	521	17.6	2.8		245	21.6	2.9	

[a]Units for the variable refer only to the mean and SD
[b]Phy = Physiological tests performed, Not Phy = Physiological tests not performed
[c]p-value is from independent sample t-test

(2) Table 30 shows the injury incidence in the physiological test subjects compared to those who were not in the physiological sample. There were no differences between the two groups of men. Women in the physiological group had a lower incidence of any injury and time-loss injury.

Table 30. Comparison of Injury Incidence Between Trainees in Physiological Sample and Those Not in the Physiological Sample

Category of Injury	Group[a]	Men N	Men Injured (%)	Men p-value[b]	Women N	Women Injured (%)	Women p-value[b]
Any Injury	Phy	170	37.6	0.84	166	56.0	0.02
	Not Phy	563	36.8		286	67.0	
Time-loss Injury	Phy	170	31.2	0.38	166	47.6	0.03
	Not Phy	563	27.7		286	58.4	
PTRP Injury	Phy	170	4.7	0.96	166	9.6	0.25
	Not Phy	563	4.8		286	13.0	

[a]Phy = Physiological group, Not Phy = Not physiological group
[b]p-value is from chi-square test comparing Phy to Not Phy

(3) Table 31 shows the descriptive statistics of the physiological variables (cohort subjects only). Compared to men, women had 78% the aerobic power (peak VO_2), 53% the lifting capacity (IDL), 58% the upper body strength (upper body static strength), 61% the lower body strength (lower body static strength), and 64% the leg power (vertical jump). Men had 88% of the flexibility (bender box) and 58% the body fat (DEXA) of women.

Table 31. Descriptive Statistics for the Physiological Variables

Variable[a]	Men N	Men Mean	Men SD	Women N	Women Mean	Women SD
Peak VO_2 (l/min)	162	3.93	0.55	153	2.46	0.43
Peak VO_2 (ml/kg*min)	162	50.6	6.2	153	39.4	5.26
Incremental Dynamic Lift (kg)	170	76.8	15.7	166	40.4	10.7
Upper Body Static Strength (kg)	170	113.4	17.5	165	65.3	11.9
Lower Body Static Strength (kg)	137	159.9	42.6	143	97.5	25.0
38 cm Pull (kg)	170	133.4	24.5	166	81.6	18.2
Vertical Jump (cm)	170	51.4	8.2	166	33.1	6.1
Flexibility (Bender Box) (cm)	169	30.3	8.2	166	34.6	8.9
Body Fat by DEXA (%)	169	16.7	6.4	166	28.8	6.5
Body Fat by Skinfold (%)	170	18.8	4.7	165	29.2	4.5
Body Fat by Circumference (%)	170	16.9	5.6	164	28.7	4.5

[a]Units for the variable refer only to the mean and SD

k. Injury Risk Factors. For the cohort, potential risk factors for time-loss injury and PTRP injury were examined. For the physiological test subjects, only risk factors for time-loss injuries were examined because of the small number of PTRP injuries in this subgroup. Among the 170 men and 166 women participating in the physiological testing, only 8 men (4.7%) and 16 women (9.6%) suffered PTRP injuries.

(1) Risk Factors for Time-loss Injury in the Cohort.

(a) Table 32 shows associations between demographic characteristics and time-loss injury incidence. Among the men, educational level was related to injury risk, but only when trainees with a general educational development (GED) were compared to high school graduates (p<0.01). Married men had a slightly higher risk of injury than single men but when marital status was stratified by age, there were no differences between married and single men (Table 33). Men in Company 8 had a higher injury incidence than the other companies (p<0.04) with the exception of Company 9. Company 9 had a higher injury incidence than Companies 6 and 7 (p<0.04). Among women, those of other ethnicity (primarily American Indians and Asians) were at lower injury risk than Whites (p=0.03), but not Blacks (p=0.12) or Hispanics (p=0.22). Women in Companies 5 and 8 had a higher injury incidence than those in Companies 4, 7, and 9 (p<0.10).

(b) Table 34 shows associations between time-loss injury incidence and the physical characteristics and fitness variables. For men, older age was associated with higher injury risk. Men >25 years were at higher risk than those <20 years (p=0.08) or those 20-25 years (p=0.02). Although the injury trend by age was similar in women, it was not statistically significant. For both men and women, lower performance on push-ups or the 2-mile run was associated with higher injury risk. There was also a significant injury trend associated with the number of sit-ups completed, thus indicating the proportion of trainees injured decreased with increasing sit-up performance levels.

Table 32. Association of Demographic Characteristics with Time-loss Injury Incidence in the Cohort

Variable	Category	Men			Women		
		N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)	N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)
Rank	E-1	482	29.5	0.19 / 0.67	267	54.3	0.84 / 0.44
	E-2	117	19.7		72	48.6	
	E-3	72	25.0		52	51.6	
	E-4	31	25.8		16	56.3	
Ethnicity	White	447	29.5	0.92	210	58.1	0.08
	Black	180	28.3		170	50.0	
	Hispanic	44	25.0		30	46.7	
	Other	30	20.0		14	28.6	
Component	Regular Army	460	28.3	0.27	277	54.2	0.17
	Reserve	98	20.4		69	43.5	
	National Guard	143	28.0		61	59.0	
Educational Level	GED	168	35.7	0.03 / 0.11	37	53.3	0.87/0.60
	High School Grad	453	23.2		299	45.9	
	1-3 yrs college	41	26.8		43	53.2	
	College Grad	27	29.6		15	53.5	
Marital Status	Single	546	25.1	0.08	292	53.1	0.49
	Married	129	32.6		76	48.7	
Company	1	110	25.5	0.04	56	64.3	0.04
	2	109	30.3		48	56.3	
	3	87	29.9		55	54.5	
	4	83	26.5		52	42.3	
	5	89	28.1		41	68.3	
	6	81	19.8		29	51.7	
	7	60	20.0		58	39.7	
	8	60	45.0		57	64.9	
	9	54	37.0		56	50.0	

Table 33. Time-Loss Injury Incidence and Marital Status of Men Stratified by Age

Age (yrs)	Married Injury Incidence (%)	Single Injury Incidence (%)	RR*	Chi-Square p-value
<20	37.5	26.7	1.4	0.35
20-25	30.0	22.0	1.4	0.16
>25	35.7	38.2	0.9	0.82

*RR=Risk Ratio (married/single)

Table 34. Association of Physical Characteristics and Physical Fitness Variables with Time-loss Injury Incidence in the Cohort

	Men				Women			
Variable	Category	N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)	Category	N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)
Age	<20 yrs	264	28.8	0.06 / 0.30	<20 yrs	189	52.9	0.35/ 0.27
	20-25	374	25.9		20-25	198	53.0	
	>25	91	38.5		>25	62	62.9	
Stature	59-67 in	184	28.8	0.72 / 0.53	58-62 in	95	51.6	0.85 / 0.97
	68-69	188	25.5		63-64	122	57.4	
	70-71	191	28.8		65-66	130	53.8	
	72-77	168	31.0		67-74	101	53.5	
Body Mass	102-143 lbs	180	30.0	0.65 / 0.83	90-119 lbs	111	52.3	0.63 / 0.32
	144-162	188	28.7		120-134	117	50.4	
	163-185	181	24.9		135-150	109	57.8	
	186-282	182	30.2		151-239	111	56.8	
BMI	16.43-21.28 m/kg^2	181	29.3	0.29 / 0.51	15.81-20.54 m/kg^2	112	49.1	0.14 / 0.24
	21.29-23.64	184	32.1		20.55-22.98	112	58.9	
	23.65-26.80	181	23.2		22.99-25.01	113	48.7	
	26.81-38.12	183	29.0		25.02-33.21	110	60.9	
First Diagnostic Push Ups	0-22 reps	179	31.8	0.02 / <0.01	0-2 reps	85	60.0	0.05 / 0.01
	23-31	161	32.3		3-5	93	60.2	
	32-41	182	24.7		6-13	102	53.9	
	42-86	168	19.6		14-50	113	43.4	
First Diagnostic Sit Ups	0-31 reps	161	31.1	0.22 / 0.04	0-22 reps	97	59.8	0.11 / 0.02
	32-41	179	29.6		23-33	95	57.9	
	42-48	170	25.3		34-44	104	53.8	
	49-85	177	22.0		45-80	96	43.8	
First Diagnostic 2-Mile Run	10.38-15.41 min	170	21.3	0.06 / 0.02	13.00-19.48 min	97	39.2	0.01 / <0.01
	15.40-17.15	172	23.4		19.49-21.65	99	54.5	
	17.14-19.21	173	31.8		21.66-23.48	94	58.5	
	19.20-31.58	170	29.6		23.49-28.68	98	60.2	

(c) Table 35 shows the association of the questionnaire variables with time-loss injury incidence. Cigarette smoking in the year prior to BCT was related to injury risk in both men and women. Among the men, smokers had a higher likelihood of injuries than trainees reporting no smoking in the last year (p<0.01) and those that had quit smoking (p<0.01). Among the women, smokers had a higher likelihood of injury than trainees who reported no smoking in the last year (p=0.01), but not those that reported they had quit (p=0.92). Smokeless tobacco use was not related to risk, but the number of users were small. Among men, self reported endurance, exercise in the last month, previous work activity (Question 9), non-varsity sports participation, and walking or hiking in the last month were associated with lower injury risk. Men reporting less than average endurance were at higher injury risk than men reporting average (p<0.01) or greater than average (p=0.05) endurance. Previous work activity (Question 9) showed an association with injury, but only when the medium group was compared to the light (p=0.02), heavy (p=0.08), or the very heavy (p=0.02) categories. Men who reported exercising <1 day/week in the last month (Question 11) were at higher injury risk than those reporting exercising 1 to 2 days/week (p=0.07) or 3 to 4 days/week (p<0.01), but not those reporting exercise 5 to 7 days/week (p=0.21). Non-varsity sports participation (Question 18) was associated with injury, but varsity sports participation was not. The group of men that had walked or hiked 5 to 7 days/week had lower risk than the groups walking or hiking <1 day/week (p=0.06) or 1 to 2 days/week (p<0.01) groups. Women performing weight training <1 day/week were at lower injury risk than those performing weight training 1 to 2 days/week (p=0.01). Among women who reported irregular periods, those reporting longer periods had lower injury risk than those reporting unpredictable changes (p=0.07), but not compared to those reporting shorter periods (p=0.18).

Table 35. Association of Questionnaire Variables with Time-loss Injury Incidence in the Cohort

Question Number and Question	Category	Men			Women		
		N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/Trend)	N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/Trend)
6. Cigarette Smoking in Last Year	Yes	50	50.0	<0.01	50	60.0	0.01
	No	175	27.6		97	38.1	
	Quit	59	18.6		39	59.0	
7. Smokeless Tobacco Use in Last Year	Yes	16	31.3	0.93	2	0	0.49
	No	205	30.2		181	49.7	
8a. Endurance	<Average	50	50.0	<0.01	51	47.1	0.74
	Average	127	22.0		117	50.4	
	>Average	49	30.6		17	41.2	
8b. Sprint Speed	<Average	41	43.9	0.11	55	45.5	0.82
	Average	139	22.6		111	50.5	
	>Average	44	29.5		19	47.4	
8c. Strength	<Average	20	40.0	0.52	26	50.0	0.89
	Average	148	28.4		123	47.2	
	>Average	55	32.9		35	51.4	

8d.	<Average	57	31.6		42	45.2	
Flexibility	Average	121	29.8	0.97	106	50.9	0.82
	>Average	45	31.1		35	51.4	
8e.	<Average	70	30.0		50	63.0	
Body Fat	Average	109	27.5	0.45	103	53.4	0.21
	>Average	45	37.5		31	48.3	
9. Physical Activity During Work Before Entering Army	Sedentary	28	42.9		44	45.5	
	Light	57	28.1		89	47.2	
	Medium	63	19.0	0.09 / 0.87	30	55.6	0.84 / 0.54
	Heavy	46	39.1		10	40.0	
	Very Heavy	28	35.7		7	57.1	
10. Leisure Activity Before Entering Army	Very Active	35	31.4		24	29.2	
	Active	68	25.0		51	49.0	
	Average	61	27.9	0.44 / 0.17	54	51.9	0.21 / 0.25
	Less Active	40	37.5		40	57.6	
	Much Less Active	18	44.4		16	37.5	
11. Exercise in Last Month	<1 day/week	40	45.0		32	46.9	
	1 days/week	43	27.9	0.07/ 0.07	27	48.1	0.89/0.89
	2-3 days/week	85	22.4		76	46.1	
	>3 days/week	55	34.5		51	52.9	
12. Running or Jogging in Last Month	<1 day/week	87	32.2		63	47.6	
	1-2 days/week	83	28.9	0.97 / 0.74	61	45.9	0.93 / 0.63
	3-4 days/week	42	31.0		41	51/2	
	5-7days/week	11	27.3		21	52.4	
13. Weight Training in Last Month	<1 day/week	128	28.9		115	54.8	
	1-2 days/week	54	27.0	0.29 / 0.17	45	33.3	0.10 / 0.12
	3-4 days/week	28	32.1		18	50.0	
	5-7days/week	13	53.0		8	37.5	
14. Walking or Hiking in Last Month	<1 day/week	96	28.1		61	47.5	
	1-2 days/week	75	41.3	0.02 / 0.16	48	54.2	0.82 / 0.83
	3-4 days/week	26	26.9		34	44.1	
	5-7days/week	28	10.7		42	47.6	
15. Other Exercise and Sports	<1 day/week	88	31.8		80	48.8	
	1-2 days/week	75	28.0	0.85 / 0.86	60	46.7	0.81 / 0.81
	3-4 days/week	43	27.9		29	44.8	
	5-7days/week	19	36.8		17	58.8	
16.Stretching	No Exercise	29	34.5		22	63.6	
	Never	39	30.8		28	42.9	
	< ½ Time	60	33.3	0.95 / 0.95	40	50.0	0.64 / 0.64
	½ Time	32	25.0		27	40.7	
	> ½ Time	19	26.3		21	42.9	
	Always	46	28.3		48	50.0	

17. Varsity Sports Participation	Yes No	128 96	28.1 33.3	0.40	93 93	45.2 51.6	0.38
18. Non-Varsity Sports Participation	Yes No	107 114	23.4 36.0	0.04	73 110	41.1 51.8	0.16
19. Lost Days for Injury	Yes No	37 186	24.3 30.6	0.44	18 168	50.0 48.2	0.89
20. Exercise Injury	Yes No	46 179	32.6 29.6	0.69	20 165	40.0 49.7	0.41
21. Surgery	Yes No	31 192	32.3 30.2	0.82	16 167	56.3 48.5	0.55
22. Hospitalization	Yes No	34 191	38.2 28.8	0.27	9 174	33.3 48.9	0.36
25. Serious Illness	Yes No	10 196	30.0 30.6	0.97	13 172	38.5 49.4	0.45
26. Colds or Flu	Yes No	38 180	26.3 30.0	0.65	32 154	56.3 46.8	0.32
27. Fever	Yes No	17 199	23.5 29.6	0.59	12 173	58.3 48.0	0.49
28. Nausea, Vomiting, Diar	Yes No	26 191	26.9 30.4	0.72	33 151	42.4 49.0	0.49
29. Foot Type	Flat High Arch Normal	24 15 178	33.3 13.3 32.0	0.31	30 14 142	33.3 35.7 44.4	0.48
30. Knee Type	Bow Legged Knocked Kneed Normal	20 7 191	45.0 28.6 29.3	0.35	12 18 156	41.7 44.4 49.4	0.82
31. Foot Problems	Yes No	6 212	33.3 30.7	0.89	10 174	40.0 50.6	0.34
32. Knee Problems	Yes No	8 208	37.5 30.3	0.66	8 178	62.5 47.8	0.41
33. Back Pain	Yes No	11 207	18.2 31.4	0.35	14 171	57.1 47.4	0.48
34. Age of Athletic Shoes	<1 Month 1-6 Months >6 Months	164 31 19	30.5 22.5 42.1	0.35	150 24 12	50.6 41.7 33.3	0.40
35. Mother or Grandmother Had Hunched Back	Yes No Do Not Know	23 148 48	34.8 29.7 31.3	0.88/0.97	30 133 23	40.0 50.4 47.8	0.59/0.51
37. First Menstrual Period	9-10 Years Old 11-15 Years Old >15 Years Old				20 156 7	55.0 47.4 57.1	0.73

38. Interrupted Periods	Yes No				18 167	61.1 47.3	0.27
39. Regular Periods	Yes No				69 116	46.4 50.0	0.63
39. If Periods Irregular, How Changed	Longer Shorter Unpredictable				13 23 29	23.1 52.2 58.9	0.10
40. Length of Period	2-3 Days 4 Days 5 Days 6 Days > 6 Days				25 33 68 24 26	44.0 66.8 42.6 50.0 46.2	0.23
42. Pregnancy	Yes No				30 133	40.0 50.4	0.30

(d) Table 36 shows the relationship of the physiological variables with time-loss injury incidence. For both men and women, lower peak VO_2 was associated with higher risk of injury. Men and women in the lowest peak VO_2 tertile (l/min) were 2.0 and 1.6 times more likely to be injured, respectively, than men and women in the highest tertile (p=0.02 for both men and women) For men (but not women) less static upper body strength was associated with greater injury risk. Men in the lowest upper body strength tertile were 1.9 times more likely to be injured than those in the highest tertile (p=0.03). Bender box flexibility was also related to risk in the men but not the women. Men in the middle tertile of flexibility (Bender Box) were 2.2 times less likely to get injured than men in the lowest tertile (p<0.01) and 1.8 times less likely to be injured than men in the highest tertile (p=0.06).

Table 36. Association of Physiological Variables with Time-loss Injury Incidence in the Cohort

Variable	Men				Women			
	Range	N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)	Range	N	Time-loss Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)
Peak VO_2	2.40-3.68 l/min 3.69-4.14 >4.14	54 55 53	38.9 32.7 18.9	0.07 / 0.03	1.70-2.20 l/min 2.21-2.57 >2.57	50 51 52	58.0 41.2 36.5	0.08 / 0.02
Peak VO_2	40.0-46.6 ml/kgXmin 46.7-53.1 >53.1	53 54 55	43.4 20.4 27.3	0.03 / 0.07	29.9-37.1 ml/kgXmin 37.1-40.8 >40.8	51 50 52	54.9 50.0 38.5	0.23/0.10
Incrementa l Dynamic Lift	41-68 kg 69-82 >82	65 55 50	32.0 32.3 29.0	0.85 / 0.64	23-32 kg 33-41 >41	54 50 62	46.3 48.0 48.4	0.97 / 0.83
Upper Body Static Strength	81-105 kg 106-119 >119	57 56 57	36.8 35.7 19.3	0.08 / 0.05	34-60 kg 61-70 >70	55 54 56	47.3 44.4 51.8	0.74 / 0.63
Lower Body Static Strength	86-135 kg 136-170 >170	45 45 47	31.1 35.6 31.9	0.89 / 0.94	45-87 kg 88-105 >105	47 48 48	46.8 45.8 54.2	0.67 / 0.47
38 Cm Upright Pull	70-124 kg 125-140 >140	57 55 58	31.6 36.4 25.9	0.48 / 0.51	41-73 kg 74-89 >89	54 55 56	46.3 50.9 46.4	0.86 / 0.99
Vertical Jump	33-47 cm 48-53 >53	56 59 55	32.1 33.9 27.2	0.73 / 0.58	17-29 cm 30-34 >34	52 57 57	50.0 45.6 47.4	0.90 / 0.79
Flexibility (Bender Box)	11-27 cm 28-35 >35	56 54 59	41.1 18.5 33.9	0.03 / 0.43	-6-31 cm 32-39 >39	55 57 54	47.3 43.9 51.9	0.70 / 0.64
Body Fat (DEXA)	4.5-13.0 % 13.1-20.1 >20.1	57 53 59	28.1 34.0 32.2	0.79 / 0.64	4.9-26.3 % 26.4-32.4 >32.4	54 55 57	42.6 47.3 52.6	0.57 / 0.29
Body Fat by Skinfold	8.1-14.7 % 14.9-20.1 >20.1	47 61 62	27.7 34.4 30.6	0.75 / 0.78	8.1-26.5 % 26.5-30.2 >30.2	49 55 61	42.9 45.5 54.1	0.46/0.23
Body Fat by Circum	4.9-13.8 % 13.9-19.3 >19.3	56 56 58	32.1 26.8 34.5	0.66 / 0.78	10.6-26.6 % 26.7-30.9 >30.9	54 54 56	46.3 50.0 48.2	0.93 / 0.84

(2) Risk Factors for PTRP Injury.

(a)Table 37 shows the association between demographic characteristics and the incidence of PTRP injury. For rank, there was a significant trend, but this was due to the lack of PTRP injuries among E-3s. Single men were at higher risk. Among the women, those of Other ethnicity (mostly Native American and Asians) were at higher risk than those of White ethnicity (p=0.10), but not Black (p=0.24) or Hispanic (p=0.38) ethnicity. Also among the women, Company 5 had more women with PTRP injuries than all other companies (p<0.02), with the exception of Company 8 (p=0.23).

Table 37. Association of Demographic Characteristics with PTRP Injury Incidence

		Men			Women		
Variable	Category	N	PTRP Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)	N	PTRP Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)
Rank	E-1	482	4.4	0.27 / 0.09	267	9.7	0.87 / 0.86
	E-2	117	2.6		72	6.9	
	E-3	72	0		52	9.6	
	E-4	31	3.2		16	6.3	
Ethnicity	White	447	4.9	0.84	210	15.7	0.07
	Black	180	3.3		170	8.8	
	Hispanic	44	4.5		30	6.7	
	Other	30	3.3		14	0	
Component	Regular Army	460	3.7	0.65	277	9.4	0.21
	Reserve	98	4.2		69	4.3	
	National Guard	143	2.9		61	13.1	
Educational Level	GED	168	3.6	0.98 / 0.84	37	5.4	0.34
	High School Grad	453	3.3		299	9.7	
	1-3 yrs college	41	4.9		43	14.0	
	College Grad	27	3.7		15	0	
Marital Status	Single	546	2.9	0.07	292	8.2	0.78
	Married	129	6.2		76	9.2	
Company	1	110	2.7	0.19	56	8.9	<0.01
	2	109	9.2		48	8.3	
	3	87	1.1		55	12.7	
	4	83	6.0		52	7.7	
	5	89	2.2		41	31.7	
	6	81	4.9		29	6.9	
	7	60	3.3		58	6.9	
	8	60	6.7		57	21.1	
	9	54	7.4		56	5.4	

(b) Table 38 shows the association of physical characteristics and APFT results with incidence of PTRP injury. None of the physical characteristics were associated with risk of a PTRP injury. Both men and women were at higher risk of PTRP injury if they were in quartiles that performed fewer push-ups or ran slower. For sit-ups, women were at higher risk if they were in the lowest performance quartile. Men in the lowest sit-up performance quartile did appear to be at higher risk than those in other sit-up quartiles, but this was not statistically significant.

Table 38. Association of Physical Characteristics and Physical Fitness with PTRP Injury Incidence

	Men				Women			
Variable	Category	N	PTPR Injury Incidence (%)	Chi-Square p-value (Overall /Trend)	Category	N	PTRP Injury Incidence (%)	Chi-Square p-value (Overall/ Trend)
Age	<20 yrs	264	4.2	0.63 / 0.41	<20 yrs	189	11.1	0.16 /0.19
	20-25	374	4.5		20-25	198	10.6	
	>25	91	6.6		>25	62	19.4	
Stature	59-67 in	184	7.1	0.23 / 0.47	58-62 in	95	13.7	0.80 / 0.96
	68-69	188	2.7		63-64	122	9.8	
	70-71	191	3.8		65-66	130	13.7	
	72-77	168	4.7		67-74	101	12.0	
Body Mass	102-143 lbs	180	5.0	0.81 / 0.96	90-119 lbs	111	17.1	0.29 / 0.21
	144-162	188	3.7		120-134	117	9.3	
	163-185	174	5.7		135-150	109	10.9	
	186-282	189	4.2		151-239	111	10.8	
BMI	16.43-21.28 m/kg^2	180	3.9	0.78 / 0.65	15.81-20.54 m/kg^2	112	13.5	0.82 / 0.54
	21.29-23.64	182	4.4		20.55-22.98	112	13.3	
	23.65-26.80	181	6.1		22.99-25.01	113	9.8	
	26.81-38.12	182	4.4		25.02-33.21	110	11.8	
First Diagnostic Push -ups	0-22 reps	179	7.3	<0.01 / <0.01	0-2 reps	85	9.4	0.20 / 0.06
	23-31	161	4.3		3-6	93	8.6	
	32-41	182	1.1		7-14	102	7.8	
	42-86	168	1.2		15-50	113	2.7	
First Diagnostic Sit-ups	0-31 reps	172	6.2	0.14 / 0.28	0-23 reps	97	10.3	0.06 / 0.02
	32-41	164	1.7		24-33	85	7.4	
	42-48	190	2.9		34-44	104	8.7	
	49-85	163	3.4		45-80	96	1.0	
First Diagnostic 2-mile Run	10.38-15.40 min	174	1.8	<0.01 / <0.01	13.00-19.48 min	96	3.1	<0.06 / <0.01
	15.41-17.12	171	1.7		19.49-21.66	94	5.1	
	17.13-19.20	170	4.6		21.67-23.48	99	9.6	
	19.21-31.58	169	5.3		23.49-28.68	97	12.2	

(3) Gender-Related Injury Risk at the Same Level of Absolute Aerobic Fitness.

(a) Table 39 shows a comparison of injury incidence of men and women on quartiles of 2-mile run times. Unlike the gender-specific quartiles above, the quartiles in Table 39 were developed from the distribution of men and women combined and thus are "gender-free." This analysis allows a comparison of the injury risk of men and women at the same absolute level of aerobic endurance. Examination of Table 39 shows that men and women in the first two quartiles were at similar injury risk. However, women in the last two quartiles had a higher injury risk than men.

Table 39. Comparison of Time-loss Injury Incidence in Men and Women by Quartiles of 2-Mile Run Times in the Cohort (Quartiles are Regardless of Gender)

2-Mile Run Time Quartiles (Quartile Ranges in Min)	Men		Women		Risk Ratio (Women/Men)	p-Value
	N	Time-loss Injury Incidence (%)	N	Time-loss Injury Incidence (%)		
10.20-16.25	258	21.3	10	30.0	1.4	0.79
16.26-18.67	215	27.4	55	36.4	1.3	0.19
18.68-21.48	154	32.5	112	51.7	1.6	<0.01
21.49-30.0	57	29.8	204	59.8	2.0	<0.01

(b) Table 40 shows a comparison of cohort men and women stratified on quartiles of peak VO_2. The quartiles in Table 40 were developed from the distribution of men and women combined and thus are "gender-free" (at each strata, men and women are compared at the same peak VO_2). This comparison allows a comparison of the injury risk of men and women at the absolute level of aerobic power. Table 40 shows that the risk of injury for men and women were not significantly different at any quartile.

Table 40. Comparison of Time-loss Injury Incidence in Men and Women by Quartiles of Peak VO_2 in the Cohort (Quartiles are Regardless of Gender)

Peak VO_2 Quartiles (Quartile Ranges in ml/kg/min)	Men		Women		p-Value
	N	Time-loss Injury Incidence (%)	N	Time-loss Injury Incidence (%)	
29.97-39.11	2	0	77	53.2	0.19
39.26-44.61	27	44.4	52	44.2	0.98
44.66-51.61	55	30.9	20	45.0	0.25
51.35-69.80	74	27.0	3	0	0.29

I. Risk Factors for Discharge.

(1) Table 41 shows the association of the demographic characteristics with discharge incidence. Women of lower rank on entry to BCT were more likely to be discharged. Women of White or Black ethnicity were more likely to be discharged than those of Hispanic and Other ethnicities (mostly American Indian and Asian). There was a similar trend for ethnicity among the men, but it was not statistically significant. Both men and women with lower educational levels were more likely to be discharged than those with higher levels of education.

Table 41. Association of Demographic Characteristics with Discharge Incidence

		Men			Women		
Variable	Category	N	Discharge Incidence (%)	Chi-Square p-value (Overall/ Trend)	N	Discharge Incidence (%)	Chi-Square p-value (Overall/ Trend)
Rank	E-1	482	10.2	0.17 / 0.12	267	19.5	0.05 / 0.02
	E-2	117	5.1		72	13.9	
	E-3	72	12.5		52	5.8	
	E-4	31	3.2		16	6.3	
Ethnicity	White	447	13.2	0.26	210	26.2	0.01
	Black	180	11.0		170	20.6	
	Hispanic	44	6.8		30	6.7	
	Other	30	3.3		14	0	
Component	Regular Army	460	10.2	0.26	277	16.6	0.50
	Reserve	98	5.1		69	18.8	
	National Guard	143	8.4		61	11.5	
Educational Level	GED	168	14.3	0.05/0.01	37	32.4	0.02 / <0.01
	High School Grad	453	7.5		299	16.1	
	1-3 yrs college	41	9.8		43	9.3	
	College Grad	27	3.7		15	6.7	
Marital Status	Single	546	9.7	0.68	292	15.8	0.27
	Married	129	8.5		76	21.1	

(2) Table 42 shows the association of the physical characteristics and the APFT results with discharge incidence. None of the physical characteristics were associated with risk of discharge in men. Women in the quartile representing high body mass or BMI were at marginally higher discharge risk. Both men and women were at higher risk of discharge if they were in quartiles of lower push-up or run performance. Men were at higher discharge risk if they were in lower sit-up performance quartiles. Among

the women, there was a significant trend indicating the proportion of female trainees with lower sit-up performance were at higher risk of discharge.

(3) Overall, women were at higher risk of discharge than men (23% vs 13%, p<0.01).

Table 42. Association of Physical Characteristics and Physical Fitness Variables with Discharge Incidence

	Men				Women			
Variable	Category	N	Discharge Incidence (%)	Chi-Square p-value (Overall/ Trend)	Category	N	Discharge Incidence (%)	Chi-Square p-value (Overall/ Trend)
Age	<20 yrs	264	14.4	0.36 / 0.43	<20 yrs	189	23.8	0.36 /0.37
	20-25	374	10.7		20-25	198	24.7	
	>25	91	13.2		>25	62	16.1	
Stature	59-67 in	184	15.8	0.19 / 0.14	58-62 in	95	22.1	0.57 / 0.30
	68-69	188	10.6		63-64	122	18.9	
	70-71	191	15.2		65-66	130	21.9	
	72-77	168	9.8		67-74	101	25.9	
Body Mass	102-143 lbs	180	15.0	0.21 / 0.28	90-119 lbs	111	19.8	0.12 / 0.10
	144-162	188	10.1		120-134	117	21.5	
	163-185	174	14.9		135-150	109	18.5	
	186-282	189	9.5		151-239	111	30.6	
BMI	16.43-21.28 m/kg^2	180	12.8	0.92 / 0.87	15.81-20.54 m/kg^2	112	19.8	0.10 / 0.10
	21.29-23.64	182	11.0		20.55-22.98	112	22.1	
	23.65-26.80	181	13.3		22.99-25.01	113	17.9	
	26.81-38.12	182	12.6		25.02-33.21	110	30.9	
First Diagnostic Push-ups	0-21 reps	174	17.2	0.01 / <0.01	0-2 reps	88	26.1	0.04 / 0.01
	22-31	163	11.0		3-6	106	16.0	
	32-40	163	7.4		7-13	101	17.8	
	41-86	179	5.0		14-50	103	10.7	
First Diagnostic Sit-ups	0-31 reps	172	14.5	0.10 / 0.03	0-22 reps	93	22.6	0.29 / 0.04
	32-40	164	8.5		23-33	108	20.2	
	41-48	190	10.0		34-43	98	15.0	
	49-85	163	6.7		44-80	98	12.2	
First Diagnostic 2-mile Run	10.38-15.45 min	174	8.6	0.07 / 0.03	13.00-19.48 min	97	9.4	0.02 / <0.01
	15.46-17.15	171	6.4		19.49-21.65	95	13.7	
	17.16-19.20	170	11.2		21.66-23.48	94	17.3	
	19.21-31.58	169	14.8		23.49-28.68	95	29.5	

7. DISCUSSION. This investigation was designed to further examine injury incidence and injury risk factors in BCT. There were three major purposes. The first was to corroborate the low injury incidence found at Ft Jackson in a recent study (83) and look for reasons why injury incidence was lower at that time. The second purpose was to examine injury incidence and lost duty days among special BCT populations (FTU personnel, discharges, and newstarts) with emphasis on the effectiveness (injury reduction and favorable training outcomes) of the FTU. A third purpose was to examine risk factors for injuries with special attention to direct measures of physical fitness. Each of these is discussed below.

a. Comparison of Present Study with Injury Incidence in Past BCT Studies.

(1) The cumulative injury incidence in other studies that have examined 8-week basic training cycles have ranged from 23 to 31% for men and 42% to 67% for women (10, 12, 67, 68, 90, 170). However, our most recent study (83) found an incidence of 15% for men and 38% for women. In the current study, we did not confirm this low injury incidence since we found injury incidences of 37% and 63% for men and women, respectively. For men, this incidence is higher than that found in any previous study; and for women, the incidence is exceeded by only one previous study (170). Several possible explanations are discussed below including:1) seasonality, 2) training differences in the battalions, 3) location of the battalions, and 4) secular differences in training practices during the two periods we tested.

(2) One possible reason the injury rates were different in the two studies may be the time of year the data was collected. Our previous study (83) was conducted in October to December, while the data reported in the present study was collected from May to July. Seasonal variations in injury rates have been previously reported in two studies (89, 124). These studies find higher rates in the summer (consistent with our finding), but they are confounded by other factors. One study (89) of elite male athletes (seven different sports), found that injury incidence increased from 9% to 19% to 32% in the October to February, March to May, and June to August timeframes, respectively. The trend was identical for women. However, the competitive season was in the summer and thus competition, rather than the summer season *per se*, may have influenced injury incidence. The other study involved rugby players (124). The athletes played back-to-back athletic seasons (not done in previous years) and the additional exposure, rather than the season, may have caused the higher injury rates. Collecting injury data from the same unit over several BCT cycles in different seasons, will assist in determining whether or not there are seasonal variations in BCT injuries. It is necessary to use the same unit because there are differences in injury incidence among units as shown in the present study (Tables 32 and 37) and in past investigations (70, 71).

(3) A probable reason to expect higher injury incidence in the summer relates to the environmental temperature. Average daily maximum and minimum dry-bulb temperatures were obtained from records at the National Atmospheric and Oceanic Administration for the Columbia, SC, Airport Station. Table 43 shows these temperatures during the period of our previous (83) and current studies. The maximum and minimum temperatures were 31°F and 29°F warmer, respectively in the May to July period. The minimum temperature in the May to July period exceeded the maximum temperature in the October to December period. In the May to July period, temperatures exceeded 100°F on 6 days.

Table 43. Average (SD) Maximum and Minimum Dry Bulb Temperatures During Two Time Periods

Timeframe	Daily Maximum (°F)	Daily Minimum (°F)
24 October – 17 December 97	61.1(8.0)	39.8(8.6)
8 May – 9 July 98	92.2(6.3)	69.2(5.8)

(4) In order to hypothesize that higher environmental temperatures influence injury incidence in BCT, the relationship must be biologically plausible. Exercise in hot environments results in dehydration, increased perceived exertion, movement of blood from the muscles to the skin (evaporative cooling), and higher rectal (core) temperature (44, 143). Compared to a cooler environment, these factors place more stress on the cardiovascular system, increasing heart rate and cardiac output (54, 143) and leading to more rapid fatigue (40, 44). Exercise in the heat also leads to increased muscle glycogenolysis, increased liver glucose output, and lactate accumulation (39, 54, 175). The additional cardiovascular and metabolic stress, over and above the normal stress of BCT, may make injuries more likely.

(5) Reduced blood flow to the musculoskeletal system (tissue ischemia) may aggravate minor injuries, converting them into more serious ones. One study found that increasing muscle temperature from 25 to 35°C substantially increased the amount of eccentric exercise-induced muscle injury (measured as a reduction in isometric force and morphologic damage) (177). Muscle tissue damage impairs muscle glycogen repletion (118) which could make fatigue more rapid in subsequent bouts of activity. Fatigue induced by the heat (40, 44) may lead to traumatic or overuse injuries as a result of changes in gait during prolonged activity (17, 36, 43). While there is no direct evidence that musculoskeletal injury incidence is directly related to the ambient temperature, the relationship does seem plausible and an area for further study. Note that environmental injuries (heat injury, cold injury, insect bites) were excluded from our analysis; thus, an increase in heat injuries cannot account for the higher incidence.

(6) Another possible reason that injury incidence differed in the two studies is the amount of PT may have differed. Injury incidence is known to differ among companies (70, 71, 83) based on the amount of PT performed (70, 71). When injury incidence was examined by company in the present study, the range was from 20% to 45% for men and 42 to 65% for women. However, in only one of companies in the current study was the incidence as low as that of companies in the earlier study, where the range was 10 to 16% for men and 23 to 44% for women (83). Data collection methods were identical in the two investigations. Although differences in PT cannot be totally dismissed, it is unlikely that this accounts for all the differences seen.

(7) A third possible reason for the differences in injury incidence in the two studies is the proximity of the 2-60th Infantry (the battalion in the 1997 investigation) to the major training areas. The 2-60th battalion was about ½ mile closer to the training areas than the 3-13th and 1-28th Infantry. The 3-13th and 1-28th were located about the same distance from the training areas with their barracks side-by-side (about a 50 yard separation). It is possible that less total marching miles was performed in the 2-60th battalion thus reducing the exposure to injury (70, 71). However, given the small difference in distance to the training areas, it is unlikely that this factor alone could account for a difference in injury incidence as large as that found here.

(8) The training cadre provided a fourth possible explanation to us. They noted that shortly before the 2-60th began their training, the number of training activities required for graduation had increased from 4 to 12. They recalled that special efforts were made to inform trainees that they must fulfill these requirements, and that missing training for any reason (including sick call) would not be an excuse. Trainees may have delayed medical care for (presumably minor) medical problems in order to complete training requirements. As time went on, the training cadre noted that most trainees were able to complete the requirements. Although trainees were still informed of the requirement, it was not emphasized to the same extent. Thus, rates of injury sick call visits may be more similar to sick call rates in past investigations.

(9) It is most likely that the lower injury incidence seen in the previous study may be a combination of the above factors, but the present study cannot provide a definitive reason or reasons for the lower rate.

b. Injuries and Limited Duty Days in Special Subgroups. A second major purpose of this investigation was to examine injury incidence and lost duty days in special BCT subgroups. These subgroups included FTU personnel, discharges, newstarts, and PTRP personnel. Two past studies have performed limited analysis on some of these (72, 83). One area of special emphasis was the effectiveness of the FTU.

(1) Fitness Training Unit.

(a) As noted above, the effectiveness of the FTU was measured by comparing FTU to non-FTU personnel on injury incidence and training outcomes (graduation/discharge incidence). However, before proceeding on a discussion of these results, we should note that at least two factors suggest FTU personnel would have a higher injury incidence than non-FTU personnel.

1. First, FTU personnel are selected for their low fitness level. It is known that for both men and women, lower levels of aerobic fitness and muscular endurance are associated with a higher incidence of injury (57, 68, 71, 83). These findings were supported by the risk factor analysis in the present study (Tables 34, 36, and 38). Since the FTU is only designed to bring fitness up to a very minimal amount, it may be expected that these individuals would be at higher risk of injury.

2. Second is the additional exposure time. Individuals who enter the FTU perform an additional 3 days to 3 weeks of training plus the normal 8-week BCT cycle. This additional time may increase exposure to injury producing events and make overuse injuries more likely.

(b) Despite these expected problems, female FTUs did very well. On the first diagnostic APFT in BCT, FTU women demonstrated the same level of aerobic endurance as the non-FTU women, since they had similar 2-mile run times (21.6 min vs 21.5 min, respectively, $p=0.85$). FTU women experienced the same injury incidence as non-FTU women (62% vs 63%, respectively, $p=0.78$ for any injury; 54% vs 55%, respectively, $p=0.92$ for time-loss injury). The average number of limited duty days was similar for FTU and non-FTU women (5.7 vs 5.3 days/trainee, respectively). The only unfavorable outcome was that FTU women were more likely to suffer an injury that would remove them from training (a PTRP injury) compared to non-FTU women (19% vs 10%, respectively, $p=0.02$). Besides injury incidence and limited duty days, training outcomes were also similar for FTU and non-FTU women. FTU women were about equally likely to graduate as the non-FTU women (60% vs 68%, respectively, $p=0.14$). FTU women were equally likely to be discharged as non-FTU women (23% vs 23%, respectively, $p=0.92$).

(c) The situation was considerably different for the FTU men. FTU men demonstrated a lower level of aerobic endurance on entry to BCT, since FTU men had significantly lower performance on the 2-mile run on the first diagnostic APFT (20.3 min vs 17.3 min, respectively, $p<0.01$). FTU-men were 1.6 times more likely to suffer any injury than non-FTU men (56.8% vs 35.7%, respectively, $p<0.01$) and 1.8 times more likely to suffer a time-loss injury (50% vs 27%, respectively, p<0.01). The average number of limited duty days/trainee was 3.2 for FTU trainees and 2.2 for non-FTU trainees. FTU men were more likely to suffer a PTRP injury; although this was not significant in our sample (10% vs 5%, respectively, p=0.16), it was significant in the larger sample of trainees collected by the Physical Therapy Clinic at Moncrief Army Community Hospital (9% vs 3%, respectively, p<0.01; see Tables 34 and 38). Training outcomes were also less favorable for FTU men. FTU men were less likely to graduate than non-FTU men (55% vs 82%, respectively, p<0.01) and more likely to be discharged (27% vs 13%, respectively, p<0.01).

(d) There are several problems with this analysis. The first problem is that we do not know the specific APFT event that sent our sample of 44 men and 89 women to the FTU. The FTU orderly room provided us with data on 30,626 receptees who took the Reception Station Physical Fitness Test from January to August 1998. These data are presented in Table 44. If our sample is representative of the FTU in general, the men were about equally likely to be sent to the FTU for failing push-ups or the run, while women were more likely to be sent for failing push-ups alone (Table 44). Since a proportionally smaller number of women were sent to the FTU for low running performance, the women's relative aerobic fitness may have been greater than the men on entry into the FTU. The additional training time in the FTU probably further improved running time.

Table 44. Proportion of Receptees Failing the Reception Station Physical Fitness Test

Event	Men (%)	Women (%)
Push-ups	3.6	13.8
Sit-ups	1.7	7.7
1-Mile Run	3.1	8.8
Any Test	6.9	23.9

(e) The second problem with this analysis is the uneven proportion of male and female receptees who are sent to the FTU. Table 44 shows that only the lowest scoring 7% of men and 24% of women were sent to the FTU. Thus, the relative fitness level of the FTU men was probably much lower than that of the FTU women because the average FTU man is in a much lower fitness percentile. It may be more difficult for this group of men to improve because they may have genetically low fitness and/or less trainability (15, 126) than the larger group of women. However, FTU personnel that did take the final (record) APFT (60% of male and 60% of female FTUs) appear to have similar trainability to non-FTU personnel on the push-up and sit-up tests. This was not the case for the 2-mile run. On this test, FTU men showed more improvement in BCT than their non-FTU counterparts (Table 16). FTU men were at a lower level of aerobic fitness on entry to BCT, and lower levels of aerobic fitness are associated with greater improvements in aerobic capacity (168). The situation was different for FTU women on the 2-mile run. FTU women showed less improvement than non-FTU women. FTU women, on entry to BCT, had fitness equal to non-FTU women. Their improvements on the final test were not as great as non-FTU women (Table 16), suggesting they had less trainability (126). This may be because they had improved to a greater extent while in the FTU. It must be remembered that the 40% of FTU men and women who did not take the final APFT (discharges and newstart-outs) could not be evaluated.

(f) The new commander of the FTU told us that because of the lack of training cadre, all personnel in the FTU ran as a single group during PT. After a briefing on this study, she obtained the personnel to organize ability group runs. Ability group runs may have increased the exercise intensity among men and women who were more aerobically fit, since they could run in a faster group. Because men on average have more aerobic fitness than women (164), it would be expected that more men would be in the ability groups that ran faster. The faster running speeds would allow the men to increase their aerobic fitness to a greater extent than in the past when they ran with a single, slower group.

(g) The downside to FTU ability group running may be a slight increase in injuries in the short term. Previous studies have suggested that faster running speeds are associated with higher risk of injury (65, 141). However, the greater amount of rest time that is allowed between training events in the FTU and the overall less physically demanding schedule may counteract the influence of the faster runs. Once the trainee enters basic training, physical activity is almost continuous and less recovery time is available. Thus, while a slightly higher injury incidence might be expected in the FTU due to ability group runs, the overall injury rate (FTU and BCT combined) might be expected to decrease because of improved fitness on entry to BCT.

(2) Discharges.

(a) Discharges amounted to 14% of the male sample, 23% of the female sample, and 17% of the total sample. In a 1984 study at Ft Jackson, Jones et al (74) reported that 21% of their sample was lost to follow-up, mostly to discharges. In our previous study (83), we calculated a 14% discharge incidence in a single battalion in 1997. Two General Account Office (GAO) reports (45, 46) indicate that 10% of Army enlistees in 1994 were separated in their first 2 months. Table 45 compares reasons for discharge in the present study with those of Ft Jackson post-wide for most of Fiscal Year (FY) 1998. Post-wide statistics were obtained from the Department of Plans, Training, and Mobilization (DPTM). In almost all categories except "Other," the discharge rate was slightly higher in the present sample.

Table 45. Comparison of Reasons for Discharge in Present Study with Ft Jackson Fiscal Year 1998 Statistics (FY 98 up to 25 August 98)

	Men		Women		Total	
	Post Statistics	Present Study	Post Statistics	Present Study	Post Statistics	Present Study
Total (N)	17,783	756	10,287	474	28,070	1230
All Discharges (%)	10.7	13.5	17.0	22.8	13.0	17.1
Chapter 11 (%)	7.9	10.2	11.9	15.4	9.4	12.2
Medical (%)	2.4	3.2	4.2	6.8	3.1	4.6
Other (%)	0.3	0.1	0.8	0.6	0.5	0.3

(b) Combining medical discharges with Chapter 11 PTRP refusals provides some perspective on the impact of major medical problems on discharge rates. About 5% of the male trainees and 13% of the females (8% of all trainees) were discharged for medically-related reasons. We found no previous published research studies on this topic in the US Army. In the British Army in 1984, 3% were discharged for medical reasons (103), but the discharge criteria may have differed.

(c) Among the men, discharged trainees were more likely to be injured than trainees who were not discharged. This was true for both medical discharges and for ELS discharges even when PTRP refusals were excluded. This was not the case for women. For women, injury incidence was similar among those discharged and those who were not, regardless of whether the discharge was for a medical reason or an ELS discharge. This gender difference suggests that injuries may be a larger factor influencing discharges in men.

(d) Discharged trainees made up 12% of the male cohort and 23% of the female cohort, but accounted for 33% of the male limited duty days and 38% of the female limited duty days. A better perspective on limited duty days experienced by discharges is provided by comparing discharges to full-cycle trainees. Among the men, discharges averaged 5.9 days of limited duty per trainee compared to 1.0 days for full-cycle trainees. Despite the similarity in injury incidence between female full-cycle and discharged trainees, discharged women averaged 8.8 days of limited duty per trainee compared to 2.7 days for full-cycle trainees. Discharged trainees experienced more days of limited duty than full-cycle trainees, despite the fact that the discharges were only present for an average of about one half of the training cycle (mean 30-32 days).

(e) We found few studies that had examined risk factors for discharges, and most of these had focused on psychological issues (13, 29, 106). In the present study, we found that lower performance on any APFT event was a risk factor for discharge, a finding not previously reported. Trainees who run slower have lower aerobic endurance than trainees who run faster. Trainees who perform fewer sit-ups and push-ups have lower muscular strength and endurance (80). On the aerobic and muscular endurance tasks performed in BCT (e.g., running, road marching, obstacle course, bayonet course, etc), less fit trainees will perform at a higher percentage of their maximal physical capacity (aerobic capacity and maximal strength and muscular endurance capacity). They will perceive BCT tasks as more difficult (14, 47), and they will fatigue more rapidly (35, 78, 162). These factors will influence their ability to train and may influence their motivation. This may make discharges a more likely possibility. Besides the greater physical difficulty, we found that the discharged men were more likely to get injured and had more days of limited duty; thus, indicating that in some cases they had exceeded their physical capacity compared to their full-cycle counterparts. While discharged female trainees were not more likely to get injured than their full-cycle peers, they did have more days of limited duty.

(f) Difference in the physical characteristics of discharged men and women was similar to that found by Jones et al (72) at Ft Jackson in 1984. In their study, none of the physical characteristics differed between men who were discharged and those who were not. In the present study, only stature differed between the groups, but only by 1.5 cm. For the females, Jones et al. (72) found that discharged women were heavier and had a greater BMI, a finding similar to that of the present study. This suggests greater body mass may be disadvantageous for women in BCT.

(3) Newstart-Outs and PTRP-Outs.

(a) Newstart-outs amounted to 4.9% of the male sample, 8.2% of the female sample, and 6.1% overall. PTRP-outs made up a large proportion of the newstart-outs. PTRP-outs amounted to 2.7% of the male sample, 6.1% of the female sample, and 4.1% overall. The proportion of trainees that became newstart-outs and/or PTRP-outs were greater in the present study than in our previous one (83) where newstart-outs amounted to 4.5% of the sample and PTRP-outs were 1% of the sample. This again supports the idea that injuries were a larger problem in the present study than the previous one. We are not sure of the long-term outcome of these newstarts, since we did not track them beyond the battalions we studied. However, some of these trainees may graduate in another battalion at a later date (83).

(b) As would be expected, newstart-outs, and especially PTRP-outs, accounted for a large proportion of limited duty days. Male newstart-outs were 5% of the cohort, but accounted for 28% of the limited duty days; female newstart-outs were 7% of the cohort, but accounted for 27% of limited duty days. Male PTRP-outs were

3% of the cohort, but were given 26% of limited duty days; female PTRP-outs were 6% of the cohort, but were given 24% of the limited duty days.

(c) Newstart-outs tended to have lower performance on the APFT regardless of whether or not they were PTRP-outs. Newstart-outs who were not PTRP were mostly newstarted for APFT failures. This again suggests the importance of physical fitness for the successful completion of BCT.

c. Injury Risk Factors. The third major purpose of this investigation was to examine risk factors for injuries with special attention to direct measures of physical fitness. For many potential risk factors, we were able to include the entire cohort in the analysis. However, because of the time consuming nature of the physiological tests and the limited amount of time we had to test trainees, only a subsample of trainees could be examined in relation to the risk factors. The association of each risk factor with injury incidence is discussed below

(1) Gender.

(a) One of the most consistently demonstrated risk factors for injuries in BCT is female gender. Table 46 shows that the risk ratio (women/men) has ranged from 1.6 to 2.5 with an average of 1.9. This finding differs considerably from findings in the athletic arena where men and women experience a similar injury risk (22, 94, 147, 153). The reason for this discrepancy may relate to differences in the relative activity intensity experienced in the two environments. In athletics, men and women generally compete separately and at their own pace. In BCT, men and women currently perform side-by-side in the same platoons, so the relative activity intensity is greater for women than for men because of women's lower physical capacity (Tables 11 and 31). For example, consider trainees on a forced road march. If they are moving at an average speed of 4 miles/hour this would require an energy equivalent of 14.2 $mlO_2/kgXmin$ (1). The average trainee in the present study had a peak VO_2 of 51 or 39 ml/kgXmin (men and women, respectively, Table 31). The energy cost of the forced march requires a relative energy cost of 28% of the average male trainee's peak VO2, but 36% of the average female trainee's peak VO_2. Thus, the average women's relative marching intensity is greater. Similar arguments could be made for other aerobic tasks or tasks requiring muscular strength or muscular endurance.

Table 46. Injury Risk Ratios (Women/Men) Among Army Trainees During 8 Weeks of BCT

Study	Year Data Collected	Risk Ratio (Any Injury)
Kowal (90)	1978	2.1
Bensel et al. (12)	1982	1.8
Jones et al. (68)	1984	1.8
Bell (10)	1988	2.1
Jones (67)	1996	1.6
Knapik et al (83)	1997	2.5
Present Study	1998	1.7

(b) If relative activity intensity were a reason for gender differences in injury incidence, then equal levels of aerobic fitness should result in similar injury risk regardless of gender. In fact, two previous studies that stratified men and women on two 2-mile run times found a similar risk of injury (18, 69). However, these studies had relatively small sample sizes. In the present study, men and women in the two quartiles representing faster 2-mile run times were at similar injury risk; however, in the other (slower) run time quartiles, women still had a higher injury risk (see Table 39). Thus, the absolute level of aerobic endurance may account for gender differences at the lower levels of aerobic endurance but not at the higher levels of aerobic endurance. To complicate matters, when examining peak VO_2 there were no differences in injury incidence at the same level of absolute fitness between men and women (see Table 40). These data may suggest that the absolute level of aerobic capacity (as measured by peak VO2) is a more critical factor in injury risk than aerobic endurance (as measured by the 2-mile run).

(c) It should be remembered that prior to 1995, women and men trained in separate companies (but were required to perform similar tasks). In these gender-segregated units, injury incidence was still about twice as great for women (first four rows of Table 46). Since 1995, men and women have served in gender-integrated BCT units, and women's injury incidence remains about twice that of the men (last three rows of Table 46).

(d) It has been suggested that women may be more susceptible to time-loss knee injuries than men, especially injuries to the anterior cruciate ligament (3, 7, 64, 145). Arendt and Dick (3) analyzed data on soccer and basketball players from the National Collegiate Athletic Association (NCAA) Injury Surveillance System. They found that women were 1.2 to 1.4 times more likely to suffer a knee injury compared to men. Gender differences in rates were greatest for anterior cruciate injuries (risk ratio (women/men)=2.4 to 4.1) and torn meniscus (risk ratio (women/men)=1.8 to 2.2), although collateral ligament and patellar tendon injury rates were also significantly higher in women. In the present study, knees were one of the major injury sites, although no anterior cruciate ligament injuries were recorded. The incidence of new knee injuries for men and women were 9% and 16%, respectively, so that women were at 1.7 times the risk of men. Besides knee injuries, we found that women's overall relative risk of injury (compared to men) increased as the gravity of the injury increased. For any injury, time-loss injuries, and PTRP injuries, the risk ratio (women/men) was 1.7, 1.9, and 2.2, respectively.

(2) Age. Older age was a significant risk factor for men and trends were similar for women. Individuals over age 25 years were at elevated risk of injury. This is consistent with most other studies (16, 48, 71), although a study of a single company of female trainees (N=165) found no association between injuries and age (170). It is interesting that infantry soldiers and mixed groups of soldiers with many different occupational specialties show a declining trend of injuries with increasing age (81, 160). The discrepancy between trainees and soldiers may be explained by the fact that basic trainees all engage in essentially the same type of PT. However, in operational U.S. Army units, older soldiers tend to be of higher rank and, consequently, in staff or supervisory positions; they may have less exposure to the physical hazards associated with their occupations, compared to younger soldiers.

(3) Marital Status. Marital status was associated with injuries in men. However, we found that older individuals were more likely to be married. When men were stratified on age, there were no differences in injury incidence between married and single trainees. Thus, in agreement with our previous study (83), age confounded the relationship between injuries and marital status.

(4) Physical Fitness. Physical fitness is defined as "the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure time pursuits and meet unforeseen emergencies" (20). Physical fitness has several measurable personal attributes or components. One group of components is related to health, the other group is related to athletic ability. Components of health-related physical fitness include cardiorespiratory endurance, muscle endurance, muscular strength, body composition, and flexibility. Components of athletic fitness include power, speed, agility, balance, coordination, and reaction time (20, 122). We directly and indirectly measured all of the health-related fitness components and one component of athletic fitness (leg power) in the present study.

(a) Aerobic Fitness.

1. Low cardiorespiratory endurance, measured by slower running performance (run times), is one of the most consistently documented risk factors for injuries in basic trainees (9, 57, 68, 71, 83, 170) as well as infantry and combat engineers (81, 129). We confirmed these results in the present study for both men and women. In addition, we extended this finding by showing that when cardiorespiratory fitness is directly measured using a treadmill running peak VO_2, individuals with low peak VO_2 are at increased injury risk. This strongly suggests that the association between injury risk and running ability (aerobic endurance) is due, in large part, to aerobic capacity and not to some other aspect of running, such as motivation, ability to pace the run, or lactate threshold. Individuals in BCT with low aerobic capacity will experience greater physiological stress at any given absolute level of performance. This added stress could result in injury through a wide variety of potential mechanisms. On the aerobic tasks performed in BCT (e.g., running, road marching, obstacle course, bayonet course, etc), less aerobically fit trainees will perform at a higher percentage of their maximal aerobic capacity. They will perceive BCT tasks as more difficult (14, 47) and may fatigue more rapidly (28, 59, 78) for both cardiovascular and metabolic reasons (28, 59, 61). Because of the more rapid fatigue, they may be more likely to change their gait (17, 36, 43) resulting in greater musculoskeletal stress to specific body areas, especially in the lower body. The combined cardiovascular, metabolic, and biomechanical stress may make injuries more likely.

2. Two previous studies have suggested that men and women at equal levels of absolute aerobic endurance (run time) have equal injury risk (18, 69). In the present study, we were able to partly confirm these data. There was a similar injury rate among men and women who ran 18.3 minutes and faster; however, women who ran slower than this had an elevated injury risk compared to men (risk ratio (women/men=2.2, 95% confidence interval =1.7 to 3.0). When men and women were considered on the basis of similar levels of peak VO_2, there were no differences in injury incidence among men and women. Thus, further research will be needed in this area, but it does appear that men and women of equal aerobic capacity have a similar likelihood of injury. Men and women of similar aerobic capacity experience similar aerobic stress in BCT, and this may be related to similar injury likelihood for the possible reasons discussed in the previous paragraph.

(b) Muscle Strength and Muscular Endurance.

1. The relationship between muscular endurance and injury incidence in BCT is not as pronounced as that with aerobic capacity. In the present study, both men and women who performed a lower number of push-ups were at elevated injury risk.

Push-ups have previously been associated with BCT injuries in men (68, 71, 83). However, only one previous study has demonstrated a relationship between push-ups and injuries in women (18); most investigations did not demonstrate a significant relationship (9, 68, 83, 170). Two of the studies that did not show a significant relationship between push-ups and injuries in women demonstrated a trend indicating that a low number of push-ups were associated with injuries (83, 170). These data indicate that upper body muscular endurance is an injury risk factor in men and may be a risk factor in women. Many tasks performed in BCT require use of the upper body. These tasks include the obstacle courses, conditioning obstacle courses, bayonet course, tactical training (low and high crawl), hand grenade qualification, and Victory Tower. While upper body injuries are a small part of the total injury picture in BCT, lack of upper body endurance capacity may result in a reliance on the lower body muscular endurance resulting in more injuries in that area.

2. Many previous investigations (18, 68, 71, 83, 170) have not demonstrated a significant relationship between BCT injuries and sit-ups. One study did demonstrate that a low number of sit-ups were associated with injuries (9), and similar weak trends have been noted in two other investigations (83, 170). The majority of the data suggests that abdominal muscular endurance is only weakly associated with BCT injuries in consonance with our finding here.

3. Four strength measures were examined in this investigation. These were the IDL, upper body static strength, lower body static strength, and the 38-cm upright pull. The only measure significantly associated with injury risk was the upper body strength measure. Men (but not women) with greater upper body strength were less likely to get injured. The upper body strength test is a measure of absolute muscle strength, and push-ups are a measure of absolute muscular endurance. Absolute muscular strength and absolute muscular endurance have been shown to be highly related (80). The finding that both push-ups and upper body strength are related to injury risk reinforces the importance of both upper body strength and upper body muscular endurance in BCT, at least in men. The only other investigation in this area was Cowan et al. (25) who found no association between the IDL and BCT injuries.

(c) Body Composition. One problem in assessing the association between body fat and injury risk in BCT is that individuals that are heavier and/or fatter are not likely to be included in the sample. This is because individuals with excessive body weight (adjusted for height and age) or individuals with excessive amounts of body fat (adjusted for age) are not allowed to enter the Army by regulation (5). Thus, the distribution of body fat in basic trainees is likely to be skewed toward leaner individuals, and it may be difficult to establish a relationship between obesity and injury risk in this population. In past epidemiological investigations (68, 69, 71, 83), BMI has been taken as an index of adiposity since it is highly correlated with both % body fat and total body fat (69, 82, 135). In fact, in the present study the correlation between these two variables was 0.77 for men and 0.71 for women (DEXA determined body fat), similar to past studies of basic trainees (69, 82). But there was no association between adiposity and injuries in the present regardless of whether the index was BMI or body fat. Nor did the method of measuring body fat (DEXA, skinfolds, or circumference) affect the association.

(d) Flexibility. We found a bimodal relationship between flexibility and injuries in men, such that those most flexible and those least flexible were at higher risk of injury compared to those of moderate flexibility. This relationship was not significant for the women, but the trend was similar to the men. This finding is identical to that found in infantry basic training (71) and in collegiate athletes (84). In the present study, flexibility was measured with the bender box, as it was in the study by Jones et al. (71). It has been demonstrated that the bender box test involves primarily hamstring flexibility (150). In the study by Knapik et al. (84), several lower body flexibility measures were obtained, but only hip flexion flexibility that demonstrated the bimodal relationship with injuries. Hip flexion, as measured in the Knapik et al. study (84), involved primarily the hamstrings also. These data suggest that it may be specifically hamstring flexibility that has the bimodal association with BCT injuries. The hamstring muscle group consists of three muscles: the semimembranosus, semitendonitis, and biceps femoris. This muscle group is unusual because it crosses two joints and the individual muscles have very long fibrous tendons.

(e) Injury Severity and Physical Fitness. Low physical fitness had a greater relative impact on PTRP injuries than on time-loss injuries. Table 47 shows the risk ratios (and 95% confidence intervals) comparing subjects in lowest versus highest quartiles of fitness for each APFT event. The relative risk of a PTRP injury for trainees in the lowest quartile of fitness was greater than that of a time-loss injury on all APFT events. This suggests that the impact of low fitness is greater for injuries that remove individuals from training. Further, the time and cost of rehabilitating trainees sent to the PTRP is substantial.

Table 47. Risk Ratios (95% Confidence Intervals) Comparing Lowest Fit Quartile to Highest Fit on the APFT Events

	Men		Women	
	Time-loss Injury	PTRP Injury	Time-loss Injury	PTRP Injury
Push-ups	1.6 (1.1-2.4)	6.1 (1.4-26.6)	1.4 (1.1-1.8)	3.5 (1.0-12.9)
Sit-ups	1.4 (1.0-2.0)	1.7 (0.7-4.6)	1.4 (1.0-1.8)	9.9 (1.3-75.8)
2-mile Run	1.4 (1.0-2.0)	3.1 (0.9-11.2)	1.5 (1.1-2.1)	4.0 (1.1-13.6)

(5) Physical Activity. In the questionnaire data, there were indications that physical activity prior to entry into the Army was associated with injuries. Men who had played non-varsity sports or had walked or hiked more frequently in the last month were at lower injury risk. However, many of the other questionnaire indicators of physical activity (activity at work, varsity sports participation, running or jogging in last month) did not show any relationship with injuries. We used both global assessments of prior physical activity (95, 166) and specific assessments that asked for recall of activities in the last month. The problems associated with attempting to evaluate prior physical activity have been well discussed (93, 95) and include recall problems and lack of a definitive criterion against which physical activity estimation methods can be validated. The present study does provide some support to previous investigations (48, 71) that suggest that lower levels of physical activity prior to BCT are associated with higher injury incidence.

(6) Cigarette Smoking.

(a) Prevalence of Smoking. In the present study 22% of the male cohort and 27% of the female cohort described themselves as smokers in the last year. This is similar to the 28% of men and 26% of women Air Force recruits who reported prior smoking in a recent report (171). The Centers for Disease Control and Prevention's (CDC) 1995 Youth Risk Behavior Survey contained questions of current and frequent smoking. Current cigarette use (1 or more cigarettes in last 30 days) was reported by 35% of male high school students and 34% of female students. Frequent cigarette use (smoking on 20 of the past 30 days) was reported by 16% of both male and female students. The differences in the smoking questions between our study and that of the CDC survey makes it difficult to make direct comparisons. However, it does appear that the proportion of trainees who reported smoking in the last year in our study fall within the range of the current and frequent smokers defined by the CDC (38).

(b) Smoking and Injuries.

1. Trainees who reported smoking in the year prior to BCT were at higher risk of injury. This is in consonance with other investigations in BCT (57, 71, 170), in infantry soldiers (130, 131), and in other occupational groups (114, 140, 161). The mechanism(s) whereby smoking influences injuries is not clear. Further, any mechanism that proposes to account for the effects of smoking on BCT injuries must take into consideration that trainees must cease smoking at the beginning of BCT. Thus, injuries in BCT are likely to be associated with some longer lasting effect of smoking. This effect does not have to be extremely long because BCT is only

8 weeks in duration, and the majority of injuries occur in the first half of BCT (e.g., 70% of male injuries and 68% of female injuries occurred in the first half of BCT in the present study).

2. Another problem in determining the mechanism of influence of smoking on injuries is that cigarette smoke is a heterogeneous aerosol containing at least 3800 substances in particulate and gaseous form. Over 90% of tobacco smoke (by weight) is in the gaseous phase. Substances in the gaseous phase include carbon dioxide, carbon monoxide, nitrogen oxides, ammonia, hydrogen cyanide, hydrazine, formaldehyde, acetone, and aerolein. Substances in the particulate phase include nicotine, toluene, phenol, and catechol. Carbon dioxide, nicotine, and carbon monoxide are by far the major components (23). While the body can readily eliminate carbon dioxide, carbon monoxide is a toxic substance that binds to hemoglobin with at least 200 times the affinity of oxygen, competes with oxygen for active sites, and can result in tissue ischemia (52). Most of the carbon monoxide taken in is eliminated by the lungs and the half life of carbon monoxide is only about 4-5 hours at sea level (155). Nicotine is a bioactive substance that increases circulating norepinephrine, epinephrine, vasopressin, growth hormone, cortisol, ACTH, and beta endophrines (11, 30). However, the effects of nicotine generally are acute, lasting for only a short period of time. The half-life of nicotine is only 30 minutes to two hours (11, 156). Thus, in order for these substances to effect injury rates in basic training they must have some longer term effect.

(c) Influence of Smoking on Estrogens and Bone Mineral Density.

1. Alterations in estrogen metabolism have been reported among smokers that may influence bone mineral density (BMD) and this could influence the likelihood of injuries. Smoking has been shown to alter the hydroxylation of estrone. Estrone can be irreversible hydroxylated to either 2-hydroxyestrone or 16-á hydroxyestrone (109). 2-hydroxyestrone has little or no effect on bone turnover and growth while 16-á hydroxyestrone has considerable influence (100, 169). Men and premenopausal women who smoke have a greater conversion (C-2 hydroxylation) of estradiol to 2-hydroxyestrone (the less active hormone) as opposed to conversion to 16-á hydroxyestrone (the more active compound) (108, 109). This could have a carry over effect into BCT, increasing susceptibility to bone injury if BMD is reduced as a result of these hormonal changes.

2. Another possible pathway that smoking may effect estrogen is conversion (aromatization) of androstenedione to estradiol. Aqueous extracts of cigarette smoke cause a dose-dependent inhibition of this reaction in human granulosa cells. When nicotine or anabasine (a component of cigarette smoke) were applied to

the granulosa cell cultures they caused a dose-dependent inhibition of this reaction (8). However, in a whole body human study using constant infusions of ^{14}C-labled estrogen tracers, only slight (but not significantly different) differences were found between female smokers and non-smokers in interconversions of androstenedione and estrone. Further, smokers and non-smokers did not differ in production rates of androstenedione, estrone, or estradiol (102). Thus, the data on this inhibitory process is conflicting.

3. Despite possible alterations in estrogen metabolism, cross-sectional investigations have not been consistent in showing differences between smokers and nonsmokers in terms of BMD, bone mineral content, or cortical area (2, 31, 60, 66, 91, 92, 107, 116, 120, 121, 139, 152, 154). Some of these differences can be explained on the basis of body physical characteristics and age. Smokers tend to be smaller and leaner than nonsmokers. There are no differences in BMD or cortical area in cross-sectional studies that have either controlled for body mass or fat mass, or in studies where body weight or BMI has been the same among smokers and non-smokers, (66, 91, 92, 107, 120). Also, when women are stratified on age, there is little effect of smoking on BMD until about age 50 years (postmenopausal); after age 50, smokers have progressively less BMD (98). Thus, while smoking may effect BMD in older smokers, differences in bone density are not likely to account for the higher injury rates in younger smokers in BCT.

(d) Effects of Smoking on Androgens and Muscle Tissue.

1. Smoking may have effects on protein deposition in muscle and other tissues throughout the body due to alterations in androgen production and metabolism. Male smokers have lower testosterone levels in the testicular veins and a lower *in vitro* secretion rates of androgen binding protein (suggestive of sertoli cell dysfunction) (151). In isolated rat and mouse Leydig cells, testosterone and androstenedione production is inhibited by nicotine in a dose dependent manner (77, 123, 174). Male rats exposed to cigarette smoke for 60 days had degradation of Leydig cells and lower plasma testosterone compared to non-exposed rats (172). In dogs exposed to the equivalent of 12 cigarettes per day for 2 years (high, medium, and low nicotine and tar groups), serum testosterone levels were decreased in a dose dependent manner and hepatic 6â-hydroxylase activity was increased suggesting increased hepatic catabolism of testosterone (111). However, a whole body human study using stable isotope tracers found that the production rate of testosterone did not differ between smokers and nonsmokers, but the metabolic clearance rate was higher in smokers (79). Thus, there is some evidence that smoking may exert effects on Leydig cell function (123, 151, 172) resulting in decreased production of testosterone (111, 151) but also some contradictory evidence (79). The evidence for increased catabolism of testosterone in smokers is more consistent (79, 111). Again,

these are acute effects but could have long-term consequences if muscle tissue turnover is effected.

2. There are few studies that have examined changes in muscle tissue in smokers, and these have examined only muscle fiber type and enzyme characteristics. Histochemical staining for myofibillar ATPase shows that smokers have a higher percentage of Type 2 muscle fibers (glycolytic profile) and lower percentage of Type 1 fibers (oxidative profile). Muscle enzyme activity of the glycolytic enzymes phosphofructokinase and lactate dehydrogenase are not different between smokers and nonsmokers. The data on oxidative enzymes 3-hydroxyacyl-CoA dehydrogenase and citrate synthase is not consistent, but cytochrome oxidase activity has been shown to be lower in smokers, even when monozygous twins are compared (96, 119). Male rats administered 50 mg/l of nicotine in their drinking water for 18 weeks showed no difference in muscle fiber type or enzyme profile (after correction for muscle protein) when compared to a control group (97).

(e) Influence of Smoking on Tissue Response to Injury.

1. Smoking has acute effects on tissue healing that may have long-term consequences and carry over into basic training. Tissues that are inadequately or incompletely healed may be more susceptible to injury. It has long been known that wound healing in smokers is delayed and less complete, complications are more likely to arise, and cosmetic results less satisfying (73, 113, 128, 134, 148). Evidence for long-term effects comes from studies on skin damage. Tobacco users have more than twice the risk of moderate to severe facial wrinkling (indicative of skin damage) when compared with non users, even after controlling for age, sun exposure, and BMI (37, 76, 112). Besides effects on skin tissue, bone healing may be impaired in smokers. Experimental fractures produced in nicotine exposed rabbits had less callus formation, delayed or inhibited bone union, and weaker bone tissue (127, 133, 149).

2. Many of these effects may be due to a combination of reduced blood flow, immune suppression, and impaired healing processes. It has been amply demonstrated that nicotine injection (32, 137, 138) or smoking (6, 128, 132, 136, 138, 142, 165) causes vasoconstriction in the cutaneous and skeletal muscle circulation, probably due to stimulation of catecholamine release (30). Smoking increases the leukocyte count in venous blood in a dose dependent manner, and smoking for a longer period of time results in a higher leukocyte count (24, 41, 42, 56, 58, 104, 110, 117, 158, 159, 173, 176). Differential counts indicate that neutrophils, monocytes, and lymphocytes are significantly elevated with a tendency for eosinophils and basophils to be elevated also (24). Cigarette smoke extracts have been shown to decrease fibroblast recruitment, proliferation, migration, and contraction (19, 115). Human

studies involving experimentally induced arm wounds show that smokers produce less hydroxproline, a marker of collagen production (50, 75).

3. While most of these effects have only been shown acutely, some studies suggest that the leukocytosis may have a longer time course (42, 58, 63, 110, 117, 159, 173). The leukocyte count is still elevated after a 1-day to 6-weeks smoking cessation (110, 117). After a 3-month smoking cessation the neutrophil concentration tended to decrease, but is still elevated relative to baseline (when subjects were smoking) (58). Leukocyte counts approach the level of non-smokers the longer the individual has stopped smoking, but men who had quit smoking for 10 years or more still had higher leukocyte counts that non smokers in one study (173). Another investigation showed that men and women who had quit smoking for an average of 11 years (95% confidence intervals on time=7 to 15 years) had counts similar to those who had never smoked (159). In a study of experimentally induced fractures in rabbits, diminishing nicotine over a 2 to 4 week period after the fracture resulted in bone vascularization similar to nonsmoking controls, but the trabecular bone area still tended to be lower (133).

(f) Cadmium. Cadmium is contained in cigarette smoke and a smoker may inhale 0.08μg per cigarette. Cadmium has been shown to accumulate in the kidney, liver, and lungs of smokers in a dose-dependent manner (99). The ability of fibroblasts to produce procollagen (a soluble precursor of collagen) appears to be inhibited by cadmium. In isolated rat fetal fibroblasts and human fetal lung fibroblasts, cadmium resulted in a dose and time dependent inhibition of procollagen production due to a decrease in procollagen synthesis and increase in degradation of newly synthesized collagen. The production of non collagen proteins was not effected in the human tissue. Cadmium also inhibited fibroblast proliferation in the rat tissue (21).

8. FINDINGS AND CONCLUSIONS.

a. The present study did not corroborate the low injury incidence found at Ft Jackson in the study conducted October to December 1997 where the cumulative injury incidence was 15% for men and 38% for women. In the present study, the cumulative incidence of injuries (any injury) was 37% for men and 63% for women. One possible explanation is differences in weather conditions. Maximum dry bulb temperatures averaged (±SD) 92±6°F in the current study (May to July 1998) and 61±8°F in the previous study (October to December 1997). Exercise in hotter environments may result in higher cardiovascular and metabolic stress making injuries more likely through increased fatigue, impaired muscle healing, and altered gait patterns. Other possible reasons for differences in injury incidence include: training differences in the battalions, location of the battalions with regards to the training areas, and temporal changes in training practices between the battalions.

b. The FTU, as structured at the time of this investigation, appears to be an effective method of reducing injuries and increasing training success in women; however, modifications are needed for men. When compared to women directly entering BCT, women coming from the FTU had the same aerobic fitness, similar injury incidence, and similar graduation success. When compared to men going directly to BCT, men coming from the FTU were less aerobically fit, were more likely to get injured, and were less likely to graduate.

c. Men who were discharged were more likely to be injured than those who were not discharged. Women who were discharged were equally likely to be injured compared to women who were not discharged. Risk factors for discharge include lower educational level and lower performance on the first diagnostic test for push-ups, sit-ups, or 2-mile run.

d. Injury incidence was higher among male and female newstart-outs, but this was primarily accounted for by the PTRP. Injury incidence among newstart-outs who were not sent to the PTRP was 21% for men and 86% for women.

e. Risk factors for time-loss injuries among the men include training company; older age; lower performance on first diagnostic push-ups, sit-ups, or the 2-mile run; cigarette smoking prior to BCT; no prior sports participation; less walking or hiking in the last month; lower peak VO_2; low upper body static strength; and lower or higher levels of hamstring flexibility. Risk factors for time-loss injuries among women included training company; low performance on the diagnostic push-ups, sit-ups, or the 2-mile run; cigarette smoking in the last year; and lower peak VO_2. Risk factors for a PTRP injury include lower performance on push-ups or the 2-mile run for both men and women.

f. The direct association of low peak VO_2 and higher injury risk suggests that associations between 2-mile run time and injuries were due to cardiorespiratory endurance and not some other aspect of the run, such as pacing ability or motivation. The finding that both push-ups and upper body strength are related to injury risk reinforces the importance of both upper body strength and upper body muscular endurance in BCT, at least in men.

9. RECOMMENDATIONS.

a. Continue efforts to improve the physical fitness of trainees prior to BCT. Low aerobic endurance, low aerobic capacity, and low upper body strength, especially, appear to be important risk factors in BCT. Trainees with these risk factors are more likely to get injured and to be discharged.

(1) The FTU is one method of improving fitness prior to BCT and should be continued and refined. No objective criteria have been established for FTU entry or exit. This could be accomplished using some of the criteria suggested here (graduation and injury incidence).

(2) A fitness test in the Military Entrance Processing Station (MEPS) may screen out the least fit enlistees before they enter basic training. A long-term solution is to support efforts to emphasize the importance of physical activity and physical fitness in elementary and high school.

b. Increase the intensity of aerobic training for men in the FTU. While women coming from the FTU were highly successful, men leaving the FTU had slower 2-mile run times and were less successful in BCT. Improving aerobic fitness in men by increasing the intensity of training may reduce injuries in BCT. On the other hand, it is possible that male injury rates will slightly increase in the FTU because of the increase in intensity. However, overall injury rates (FTU and BCT combined) may be lower because of the greater rest and recovery time in the FTU.

c. Conduct an investigation to determine if injury incidence differs in different seasons in BCT. The same training units should be investigated to reduce the possibility of training variations between units. The present study suggests that injuries are lower in BCT cycles conducted in the fall than they are in BCT cycles conducted in the spring-summer. This may have implications for the allocation of medical care suggesting more care is needed in the summer and less in the fall/winter. If injury rates are lower in the fall, further efforts will be necessary to determine if training or climatic factors (e.g., cooler temperatures) explain the differences.

d. It is known that there is a dose-response relationship between the amount of training and risk of injury: the more physical activity a group does, the more injuries will occur (70, 88, 105). It is also known that there are thresholds of training above which fitness does not improve substantially but injury rates still increase (125, 146). It may be that lower volumes of training in the early weeks of training, more measured progression of training, and greater emphasis on ability groups will reduce injury rates while still achieving adequate fitness.

APPENDIX A

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APPENDIX B

BASIC COMBAT TRAINING

1. We observed many parts of BCT during the training cycle. Training differs only very slightly within companies; each company followed very similar practices. This section provides some general observations on BCT as it was conducted during this investigation.

2. The training day began at 0515-0530 with a wake up by the drill sergeant. The trainees dressed in PT uniform and performed PT for 1-1.5 hours. After PT, trainees returned to the barracks, changed into battle dress uniforms (BDUs), had a formation, and filed into the mess hall for breakfast. After breakfast, the training event of the day was conducted. Often these involved non-tactical road marches to the training site, classroom instruction in the battalion area or troops were motored to training areas. Lunch was generally served at 1200, either in the battalion mess hall or in the field. Training continued in the afternoon with dinner at about 1700. Generally training was continued until about 2030, Trainees had personal time until 2130 when lights went out. Generally, no training was conducted on Sunday.

3. The morning PT sessions were conducted 4-6 times per week except during the week of the field training exercise (FTX) when it was conducted 2-3 times. PT sessions generally alternated between "cardiorespiratory (CR) days " and "muscle strength (MS) days". Both days involved about 15 to 20 minutes of stretching various muscle groups starting with the neck and working down. CR days involved long distance running (1/2to 3 miles) and sprinting with some push ups and sit-ups. Within a company, there were 4 running "ability groups" that were generally formed on the basis of the distribution of first diagnostic APFT run times (25% in each group). MS days involved many different types of push-ups and sit-ups in addition to a wide variety of calisthenic exercises, including inverted crawls, hops, high jumps, supine bicycles, and others. Two or three times during the cycle, sports activities were substituted for exercises. Water consumption was emphasized during PT: full canteens were mandatory at the start of PT, and drinking breaks were taken during the session.

4. Basic training was divided into three phases, each 2 to 3 weeks in duration. All phase include non tactical road marches of varying length to and from training sites in which trainees marched in formation.

a. The first phase (Patriot or Red Phase) was 2 weeks in length. Introductory lessons were conducted in customs and courtesies, drill and ceremony, physical fitness, nutrition, first aid, wearing of the uniform, rifle maintenance, the manual of arms, and radio/telephone communication procedures. Red phase was characterized by total cadre control and constant supervision. Army values were introduced and reinforced throughout training. Major PT events include Victory Tower, introductory tactical road march, introduction to bayonet training, and the conditioning obstacle course.

b. The second phase (Gunfighter or White Phase) was 3 weeks long. Emphasis was on basic rifle marksmanship (BRM); 14 BRM lessons and a final test were required to qualify with the M16 rifle. Training on the M60 machine gun, M203 grenade launcher, and M18 Claymore mine were also provided. Major events requiring physical activity included continued bayonet training (including pugil training); nuclear, biological, and chemical defense; hand to hand combat; two tactical foot marches; and continued drill and ceremony training.

c. The final phase (Warrior or Blue Phase) was 3 weeks in length. It was designed to teach individual tactical skills and emphasize the importance of teamwork. Combat maneuver, live fire exercises, and a e day field training exercise (FTX, Victory Forge) were conducted. Major physical activities included the hand grenade qualification range, individual tactical training, the confidence course, conditioning obstacle course, and the FTX. For the FTX, the trainee spends 3 days in the field demonstrating proficiency in common military skills. Soldiers participated in a graduation ceremony then moved on to their advanced individual training sites.

APPENDIX C

TRAINEE MEDICAL CARE

1. A trainee in need of medical care at Ft Jackson could enter the medical system either at the training battalion or the hospital emergency room. Daily sick call was conducted by a medic at the battalion aid station. The medic made the decision to treat the trainee at the battalion and return him or her to duty, or refer the trainee to the McWethy Troop Medical Clinic (TMC) for further evaluation/treatment. For some follow-up visits or injuries outside of sick call, the trainee could report directly to the TMC. If the TMC was closed, the trainee could obtain medical care at the Moncrief Army Community Hospital Emergency Room. Here, a medic also performed an initial screening and either treated and returned the trainee to duty or referred the trainee to a higher level of care.

2. Whenever a trainee entered the medical system, medical record forms were generated and placed in the trainee medical record. Trainee medical records were stored at the TMC.

APPENDIX D
BASIC COMBAT TRAINING QUESTIONNAIRE (Ft Jackson, 1998)

In this questionnaire you will be asked about yourself and your lifestyle. Please answer each question to the best of your ability.

1.Name: ______________________________ 2. SSN: __________________________
(Last, First, Middle)

3. Date of Birth: _____/_____/_____ 4. Age: ________ 5. Gender: Male _____ Female _____
Mo Day Year

TOBACCO USE

6. SMOKING: Which statement best describes your smoking habits in the last year?
___ I have never been a smoker
___ I smoked but quit --→ ___I quit less than 6 months ago
___ I smoke 10 or fewer cigarettes per day ___ I quit 6 months to 1 year ago
___ I smoke 11 to 20 cigarettes per day ___ I quit more than a year ago
___ I smoke more than 20 cigarettes per day

7. SMOKELESS TOBACCO: What statement best describes your use of smokeless tobacco (chewing, dipping, or pinching) in the last year?
___ I have never used smokeless tobacco
___ I used smokeless tobacco but quit ----------------------→ ___I quit less than 6 months ago
___ I use smokeless tobacco one time per day or less ___ I quit 6 months to 1 year ago
___ I use smokeless tobacco 2-4 times per day ___ I quit more than a year ago
___ I use smokeless tobacco 5-10 times per day
___ I use smokeless tobacco more than 10 times per day

PHYSICAL FITNESS

8. CURRENT PHYSICAL FITNESS: How would you rate your present level of each of the following (compared to others of your age and sex):

	Far Less Than Average	Less Than Average	Average	Greater Than Average	Far Greater Than Average
a. Endurance	________	________	________	________	________
b. Sprint Speed	________	________	________	________	________
c. Strength	________	________	________	________	________
d. Flexibility	________	________	________	________	________
e. Body Fat	________	________	________	________	________

PHYSICAL ACTIVITY

9. PHYSICAL ACTIVITY DURING WORK: Which description best matches the activity level required by your most recent job prior to entering the Army?
___ Sedentary Work (Mostly sitting with some walking or standing. Examples: secretarial, typing, bookkeeping, student)
___ Light Work (Much walking, standing, or use of arms and hands. Examples: retail sales, waiter/waitress, gas station attendant)
___ Medium Work (Frequent lifting and carrying up to 25 pounds. Examples: machinist, bricklayer, carpenter, cook)
___ Heavy Work (Frequent lifting or carrying of 25 to 50 pounds. Examples: jackhammer operator, yard work, frame carpenter, pipe fitter)
___ Very Heavy Work (Frequent lifting or carrying of more than 50 pounds. Examples: miner, laborer, furniture mover)

10. PHYSICAL ACTIVITY IN LEISURE TIME: Outside of work, how would you rate yourself as to the amount of physical activity you performed prior to entering the Army, compared to others of your age and sex?

___ Much more active
___ Somewhat more active
___ About the same
___ Somewhat less active
___ Much less active

EXERCISE AND SPORTS IN LAST MONTH

11. EXERCISE IN THE LAST MONTH: Over the last month, how often did you exercise or play sports for 15 minutes or more?

___ No exercise or sports in the last month
___ Less than once per week
___ One time per week
___ Two or three times per week
___ Four or more times per week

12. RUNNING OR JOGGING: How many days per week did you run or jog in the last month on average?

___ None
___ Less than 1
___ 1-2 days/wk
___ 3-4 days/wk
___ 5-6 days/wk
___ 7 days/wk

13. WEIGHT TRAINING: How many days per week did you do weight training (free weights, universal, nautilus, etc.) in the last month on average?

___ None
___ Less than 1
___ 1-2 days/wk
___ 3-4 days/wk
___ 5-6 days/wk
___ 7 days/wk

14. WALKING OR HIKING: How many days per week did you walk or hike in the last month on average?

___ None
___ Less than 1
___ 1-2 days/wk
___ 3-4 days/wk
___ 5-6 days/wk
___ 7 days/wk

15. OTHER EXERCISE OR SPORT: How many days per week did you exercise or play sports in the last month on average (other than running, weight training, walking, or hiking)?

___ None
___ Less than 1
___ 1-2 days/wk
___ 3-4 days/wk
___ 5-6 days/wk
___ 7 days/wk

16. STRETCHING: Was stretching a regular part of your exercise program, either before or after exercise?

___ I do not exercise
___ No, I exercise but do not stretch
___ Less than ½ the time
___ About ½ the time
___ More than ½ the time
___ Always

ORGANIZED SPORTS

17. VARSITY SPORTS PARTICIPATION: Did you participate in varsity sports in school or college?

___ Yes Years Played __98 __97 __96 __95 __94 __93 __92 __91 __90 __89 __88 or before
___ No

18. NON-VARSITY SPORTS PARTICIPATION: Did you participate in non-varsity organized sports, like YMCA or church leagues, intramural teams or American Legion baseball? This includes other competitive activities like bicycle racing, competitive running, or weight lifting.

___ Yes Years Played __98 __97 __96 __95 __94 __93 __92 __91 __90 __89 __88 or before

___ No

PAST INJURIES AND HEALTH

19. LOST WORK OR SCHOOL DAYS: Have you ever suffered an injury or accident that caused you to stay home from school or work for 1 week or more?

___ Yes

___ No

If yes, what was the most recent injury? ______________________________

Also, what year did it occur? __________________________

20. EXERCISE OR SPORT INJURIES: Have you ever had an exercise or sports related injury that caused you to decrease or quit exercising or practicing for 1 week or more?

___ Yes

___ No

If yes, what was the most recent injury? ______________________________

Also, what year did it occur? __________________________

21. SURGERY: Have you ever had an injury or accident that required surgery to repair the damage?

___ Yes

___ No

If yes, what was the most recent injury? ______________________________

Also, what year did it occur? __________________________

22. HOSPITALIZATION: Have you ever had an injury that caused you to be hospitalized overnight?

___ Yes

___ No

If yes, what was the most recent injury? ______________________________

Also, what year did it occur? __________________________

23. INJURIES: Have you ever been injured or had an accident to one of the following body parts that caused you to alter your daily activity or miss school or work for several days? First, check "yes" for all body parts injured this severely. Check "no" for all body parts not injured this severely. Next, for all those checked yes, give in the space provided the name of the most recent injury, year of the injury, and the number of days it took to recovery from the injury.

INJURIED Yes	INJURIED No	BODY PART	INJURY NAME	YEAR(S) OF INJURY	DAYS TO RECOVER
___	___	Head			
___	___	Neck			
___	___	Shoulders			
___	___	Upper Arm			
___	___	Lower Arm			
___	___	Hand			
___	___	Chest			
___	___	Upper Back			
___	___	Lower Back			
___	___	Stomach			
___	___	Hip			
___	___	Thigh			
___	___	Knee			
___	___	Calf			
___	___	Ankle			
___	___	Foot			

24. BACK AND LEG INJURIES: Have you ever had one of the following injuries to your back or legs? Check "yes" in front of the injuries you have suffered. Check "no" in front of the injuries you have not suffered. For those checked yes, give the name of the most recent injury, part of the back or leg injured, year of the injury, and the severity of the injury.

Mild- the injury did not affect your daily activities
Moderate – the injury affected your daily activities for 1 to 7 days
Severe - the injury affected your daily activities for more than 7 days

INJURIED Yes	INJURIED No	TYPE OF INJURY	PART OF LEG OR BACK	YEAR(S) OF INJURY	SEVERITY Mild	Moderate	Severe
___	___	Broken Bone					
___	___	Stress Fracture					
___	___	Torn Cartilage					
___	___	Torn Ligaments					
___	___	Knee Injury					
___	___	Sprained Ankle					
___	___	Other Sprain					
___	___	Tendinitis					
___	___	Ruptured Tendon					
___	___	Muscle Pull					
___	___	Other ___________					
___	___	Other ___________					

25. SERIOUS ILLNESS HEALTH PROBLEMS: Have you ever had a serious illness or health problem other than an injury?

___ Yes
___ No

List all the serious illnesses or problems and the years they occurred______________________________

26. COLDS OR FLU: Have you had a cold or flu in the last 2 weeks?
___ Yes
___ No

27. FEVER: Have you had a fever in the last 2 weeks?
___ Yes
___ No

28. NAUSEA, VOMITING, AND DIARRHEA: Have you had nausea with vomiting, and/or diarrhea in the last 2 months (not associated with drinking)?
___ Yes
___ No

MISCELLANEOUS QUESTIONS

29. FOOT TYPE: How would you classify your feet?
___ Flat
___ High Arch
___ Normal

30. KNEE TYPE: How would you classify your knees?
___ Bow legged (knees point outward)
___ Knocked kneed (knees point inward)
___ Normal

31. FOOT PROBLEMS: Do you have problems with your feet that cause you to limit your daily activity some times?
___ Yes
___ No

32. KNEE PROBLEMS: Do you have problems with your knees that cause you to limit your daily activity some times?
___ Yes
___ No

33. BACK PAIN: Do you have problems with your back that cause you to limit your daily activity some times?
___ Yes
___ No

34. AGE OF YOUR ATHLETIC SHOES: About how long ago did you buy your athletic shoes?
___ Do not have athletic shoes yet
___ Brand new
___ Less than 1 week
___ 1 week to 1 month
___ More than 1 month but less than 6 months
___ 6 months to 1 year
___ More than 1 year

35. MOTHER AND GRANDMOTHER: Did your mother or grandmothers ever develop a hunched-over appearance or ever break a hip?
___ Yes
___ No
___ Do not know

QUESTIONS FOR WOMEN ONLY

37. FIRST MENSTRUAL PERIOD: How old were you when you had your first menstrual period? ______

38. INTERRUPTED PERIODS: Have your periods ever stopped for 6 or more months (except for pregnancy)?
___ Yes
___ No
If yes, give the most recent year _________

39. REGULARITY OF PERIOD: In the past year has the number of days between periods changed?
___ Yes --→ If yes, how have your periods changed?
___ No
___ Longer
___ Shorter
___ Unpredictable

40. LENGTH OF PERIODS: How many days does your period last? ________

41. DATE OF LAST PERIOD: When did your last period start? ____________
month/day/year

42. PREGNANCY: Have you ever had a baby (including stillborn)?
___ Yes
___ No
If yes, give the month and year of last delivery _______

THANKS FOR YOUR TIME AND HELP. GOOD LUCK IN THE ARMY!

APPENDIX E

INCIDENCE RATE ANALYSIS OF COHORT AND SUBGROUPS

1. One problem with the analysis of groups that did not complete the full BCT cycle (discharges, newstart-outs, newstart-ins, PTRP-outs, and PTRP-ins) is that their exposure to potentially injury producing events is not the same since they spent varying amounts of time in the unit. To correct for this, we performed an incidence rate analysis (injuries/100 person-days) on subgroups that had information regarding how much time they spent in BCT units. These were limited to full-cycle trainees, discharges, and PTRP-outs. Not all individuals in these subgroups had time-in-unit data, but any trainee that did have this information was included in the analysis.

2. Table 1 shows the incidence rate analysis. For full-cycle trainees, the injury incidence analysis and incidence rate analysis would be expected to produce similar results because exposure time (i.e., time in BCT) is the same for all full-cycle trainees. Among full-cycle trainees and the cohort, women had a significantly greater incidence rate for any injury and time-loss injury compared to men ($p<0.01$ for all comparisons). Among the discharges men and women had similar injury rates for both any injuries ($p=0.76$) and time-loss injuries ($p=0.82$). Among the PTRP-outs, men and women also had similar injury rates for any injury ($p=0.80$) and time-loss injury ($p=0.94$). Comparisons among groups indicated that full-cycle trainees had lower injury rates than discharges and PTRP-outs for both any injury and time-loss injury both among the men and the women ($p<0.01$ for all comparisons).

Table 1. Incidence Rate Analysis of Full-cycle, Discharges, and PTRP-outs

Group or Subgroup	Men				Women			
	Total (N)	Any Injury (injuries/ 100 person-days)	Time-loss Injury (injuries/ 100 person days)	PTRP Injury (injuries/ 100 person days)	Total (N)	Any Injury (injuries/ 100 person days)	Time-loss Injury (injuries/ 100 person days)	PTRP Injury (injuries/ 100 person days)
Cohort	709	0.73	0.56	3.32	435	1.33	1.33	3.22
Full-cycle	604	0.57	0.41	None	305	1.07	0.90	None
Discharges	86	2.09	1.87	3.14	105	2.20	1.95	2.87
PTRP-out	19	3.14	3.14	3.32	25	3.22	3.22	3.22

3. Tables 2 to 5 show the risk factor analysis. The results are generally consistent with the injury incidence data. Significant risk factors for the men include educational level, first diagnostic push-ups, first diagnostic 2-mile run, cigarette smoking, self rated endurance, self rated walking or hiking in the last month, non-varsity sports participation, peak VO_2, upper body static strength, and flexibility. For women, significant risk factors include ethnicity, first diagnostic push-ups, first diagnostic 2-mile run, cigarette smoking, leisure activity before entering the Army, and peak VO_2.

Table 2. Association of Demographic Characteristics with Time-loss Injury Incidence Rate

		Men			Women		
Variable	Category	N	Incidence Rate (inj/100 person-days)	Chi-Square p-value	N	Incidence Rate (Inj/100 person-days)	Chi-Square p-value
Rank	E-1	469	0.74	0.28	256	1.25	0.96
	E-2	113	0.57		69	1.28	
	E-3	68	0.53		50	1.14	
	E-4	29	0.64		16	1.21	
Ethnicity	White	435	0.58	0.76	205	1.27	0.10
	Black	172	0.56		162	1.02	
	Hispanic	44	0.48		29	0.86	
	Other	29	0.40		14	0.53	
Component	Regular Army	440	0.55	0.29	266	1.08	0.62
	Reserve	98	0.39		66	0.90	
	National Guard	140	0.56		59	1.13	
Educational Level	GED	163	0.72	0.04	37	1.03	0.99
	High School Grad	440	0.45		291	1.07	
	1-3 yrs college	41	0.51		43	1.05	
	College Grad	25	0.52		15	1.01	
Marital Status	Single	528	0.49	0.16	284	1.06	0.83
	Married	127	0.64		75	1.02	
Company	1	103	0.53	0.17	52	1.23	0.11
	2	104	0.61		48	1.16	
	3	86	0.56		54	1.15	
	4	79	0.51		45	0.90	
	5	87	0.52		40	1.75	
	6	80	0.39		28	1.05	
	7	59	0.40		56	0.73	
	8	59	0.95		57	1.47	
	9	52	0.73		55	1.11	

Table 3. Association of Physical Characteristics and Physical Fitness Variables with Time-loss Injury Incidence Rate

Variable	Men				Women			
	Category	N	Incidence Rate (inj/100 person-days)	Chi-Square p-value	Category	N	Incidenc e Rate (inj/100 person-days)	Chi-Square p-value
Age	<20 yrs	255	0.57	0.12	<20 yrs	182	1.10	0.64
	20-25	362	0.50		20-25	193	1.14	
	>25	88	0.77		>25	58	1.33	
Stature	59-67 in	176	0.55	0.83	58-62 in	93	1.08	0.96
	68-69	180	0.50		63-64	121	1.20	
	70-71	185	0.59		65-66	124	1.12	
	72-77	166	0.60		67-74	93	1.15	
Body Mass	102-143 lbs	168	0.58	0.91	90-119 lbs	107	1.09	0.91
	144-162	187	0.56		120-134	105	1.05	
	163-185	171	0.51		135-150	116	1.17	
	186-282	181	0.58		151-239	103	1.25	
BMI	16.43-21.28 m/kg^2	170	0.58	0.42	15.81-20.54 m/kg^2	107	1.01	0.30
	21.29-23.64	181	0.63		20.55-22.98	111	1.25	
	23.65-26.80	179	0.45		22.99-25.01	108	1.01	
	26.81-38.12	172	0.58		25.02-33.21	103	1.33	
First Diagnostic Push-ups	0-22 reps	166	0.65	0.03	0-2 reps	108	1.28	0.06
	23-31	158	0.65		3-5	83	1.11	
	32-41	179	0.48		6-13	97	1.15	
	42-86	167	0..37		14-50	97	0.83	
First Diagnostic Sit-ups	0-31 reps	153	0.65	0.22	0-22 reps	94	1.25	0.25
	32-41	170	0.57		23-33	93	1.20	
	42-48	169	0.50		34-44	102	1.10	
	49-85	175	0.42		45-80	95	0.86	
First Diagnostic 2-mile Run	10.38-15.41 min	161	0.63	0.07	13.00-19.48 min	93	1.28	0.03
	15.40-17.15	165	0.62		19.49-21.65	94	1.29	
	17.14-19.21	168	0.45		21.66-23.48	95	1.07	
	19.20-31.58	169	0.40		23.49-28.68	96	0.75	

Table 4. Association of Questionnaire Variables with Time-loss Injury Incidence Rate

Question Number and Question	Category	Men			Women		
		N	Incidence Rate (inj/100 person-days)	Chi-Square p-value	N	Incidence Rate (inj/100 person-days)	Chi-Square p-value
6. Cigarette Smoking in Last Year	Yes	50	1.01	<0.01	49	1.45	0.04
	No	174	0.48		134	0.90	
7. Smokeless Tobacco Use in Last Year	Yes	15	0.58	0.82	2	0	
	No	201	0.57		165		
8a. Endurance	<Average	49	1.05		50	1.02	
	Average	126	0.42	<0.01	115	1.07	0.88
	>Average	48	0.58		16	0.88	
8b. Sprint Speed	<Average	41	0.89		55	1.02	
	Average	138	0.51	0.16	108	1.06	0.98
	>Average	36	0.51		15	1.05	
8c. Strength	<Average	19	0.78		26	1.08	
	Average	148	0.56	0.57	212	0.99	0.61
	>Average	48	0.70		29	1.31	
8d. Flexibility	<Average	56	0.63		42	1.01	
	Average	121	0.58	0.96	105	1.07	0.96
	>Average	42	0.61		29	1.00	
8e. Body Fat	<Average	69	0.60		48	0.62	
	Average	109	0.53	0.50	102	1.09	0.44
	>Average	38	0.78		27	1.23	
9. Physical Activity During Work Before Entering Army	Sedentary	28	0.89		42	0.95	
	Light	57	0.54		88	1.02	
	Medium	62	0.37	0.15	36	1.18	0.97
	Heavy	46	0.80		10	0.95	
	Very Heavy	28	0.70		7	1.11	
10. Leisure Activity Before Entering Army	Very Active	35	0.62		24	0.58	
	Active	67	0.49		50	1.11	
	Average	61	0.53	0.52	53	1.11	0.08
	Less Active	40	0.80		39	1.16	
	Much Less Active	18	0.89		16	0.87	
11. Exercise in Last Month	<1 day/week	40	0.88		32	0.99	
	1-2 days/week	43	0.54	0.18	27	1.02	0.97
	3-4 days/week	84	0.44		73	1.00	
	>4 days/week	55	0.69		51	1.12	

12. Running or Jogging in Last Month	<1 day/week	87	0.63	0.98	63	0.98	0.98
	1-2 days/week	82	0.57		59	1.05	
	3-4 days/week	42	0.62		40	1.05	
	5-7days/week	11	0.54		21	1.13	
13. Weight Training in Last Month	<1 day/week	128	0.56	0.49	112	1.19	0.26
	1-2 days/week	53	0.57		45	0.70	
	3-4 days/week	28	0.63		18	1.08	
	5-7days/week	13	1.11		8	0.75	
14. Walking or Hiking in Last Month	<1 day/week	96	0.55	0.05	60	0.99	0.75
	1-2 days/week	75	0.83		47	1.24	
	3-4 days/week	26	0.51		33	0.90	
	5-7days/week	27	0.21		42	1.01	
15. Other Exercise and Sports	<1 day/week	88	0.62	0.92	80	1.00	0.94
	1-2 days/week	75	0.55		59	1.05	
	3-4 days/week	42	0.56		27	0.97	
	5-7days/week	19	0.74		17	1.23	
16.Stretching	No Exercise	29	0.66	0.99	22	1.36	0.87
	Never	39	0.61		28	0.95	
	< ½ Time	60	0.64		40	1.15	
	½ Time	31	0.50		27	0.87	
	> ½ Time	19	0.51		19	0.91	
	Always	46	0.57		47	0.98	
17. Varsity Sports Participation	Yes	128	0.54	0.38	91	0.89	0.16
	No	95	0.67		92	1.20	
18. Non-Varsity Sports Participation	Yes	106	0.46	0.09	72	0.84	0.17
	No	114	0.71		108	1.15	
19. Lost Days for Injury	Yes	37	0.48	0.53	17	1.06	0.94
	No	185	0.60		166	1.03	
20. Exercise Injury	Yes	46	0.64	0.73	20	0.87	0.59
	No	178	0.58		162	1.06	
21. Surgery	Yes	31	0.64	0.85	15	1.20	0.70
	No	191	0.60		165	1.04	
22. Hospitalization	Yes	34	0.77	0.34	9	0.79	0.62
	No	190	0.57		171	1.04	
25. Serious Illness	Yes	10	0.65	0.90	13	0.77	0.46
	No	195	0.60		169	1.06	
26. Colds or Flu	Yes	38	0.53	0.76	30	1.09	0.82
	No	179	0.59		153	1.02	
27. Fever	Yes	17	0.45	0.60	11	1.35	0.52
	No	198	0.58		171	1.02	
28. Nausea, Vomiting, Diar	Yes	26	0.53	0.76	33	0.96	0.80
	No	190	0.60		148	1.03	

29. Foot Type	Flat	24	0.70		30	0.96	
	High Arch	14	0.26	0.36	14	0.86	0.84
	Normal	178	0.62		139	1.07	
30. Knee Type	Bow Legged	20	0.96		10	0.56	
	Knocked Kneed	7	0.57	0.40	18	1.09	0.47
	Normal	190	0.57		155	1.06	
31. Foot Problems	Yes	6	0.78	0.72	10	0.27	0.08
	No	211	0.60		171	1.07	
32. Knee Problems	Yes	8	0.69	0.80	8	1.51	0.42
	No	207	0.60		175	1.01	
33. Back Pain	Yes	11	0.34	0.35	13	1.25	0.60
	No	206	0.62		169	1.01	
34. Age of Athletic Shoes	<1 Month	132	0.63		118	1.14	
	1-6 Months	31	0.43	0.48	22	0.79	0.38
	>6 Months	19	0.78		12	0.69	
35. Mother or Grandmother Had Hunched Back	Yes	23	0.70		30	0.87	
	No	147	0.58	0.89	130	1.07	0.79
	Do Not Know	48	0.62		23	1.06	
37. First Menstrual Period	9-10 Years Old				20	1.19	
	11-15 Years Old				153	1.01	0.88
	>15 Years Old				7	1.09	
38. Interrupted Periods	Yes				18	1.43	0.29
	No				164	1.00	
39. Regular Periods	Yes						
	No						
39. If Periods Irregular, How Changed	Longer				13	0.49	
	Shorter				23	1.21	0.21
	Unpredictable				27	1.28	
40. Length of Period	2-3 Days				25	0.88	
	4 Days				26	1.01	
	5 Days				32	1.57	0.39
	6 Days				68	0.93	
	> 6 Days				23	0.93	
42. Pregnancy	Yes				40	1.19	0.50
	No				140	1.00	

Table 5. Association of Physiological Variables with Time-loss Injury Incidence Rate

Variable	Men Range	Men N	Men Incidence Rate (inj/100 person-days)	Men Chi-Square p-value	Women Range	Women N	Women Incidence Rate (inj/100 person-days)	Women Chi-Square p-value
Peak VO_2	2.40-3.68 l/min	54	0.74	0.06	1.70-2.20 l/min	49	1.25	0.09
	3.69-4.14	55	0.62		2.21-2.57	51	0.89	
	>4.14	53	0.40		>2.57	51	0.90	
Peak VO_2	40.0-46.6 ml/kgXmin	53	0.87	0.04	29.9-37.16 ml/kgXmin	51	1.24	0.05
	46.7-53.1	54	0.39		37.1-40.8	48	1.05	
	>53.1	55	0.52		>40.8	52	0.77	
Incrementa l Dynamic Lift	41-68 kg	65	0.63	0.85	23-32 kg	54	0.99	0.98
	69-82	55	0.64		33-41	49	1.03	
	>82	50	0.54		>41	61	1.04	
Upper Body Static Strength	81-105 kg	57	0.73	0.04	34-60 kg	55	1.04	0.78
	106-119	56	0.67		61-70	54	0.92	
	>119	57	0.42		>70	54	1.12	
Lower Body Static Strength	86-135 kg	45	0.61	0.96	45-87	46	0.97	0.75
	136-170	45	0.68		88-105	48	0.96	
	>170	47	0.62		>105	47	1.17	
38 Cm Upright Pull	70-124 kg	57	0.61	0.60	41-73 kg	53	1.00	0.97
	125-140	55	0.71		74-89	55	1.07	
	>140	58	0.51		>89	55	1.01	
Vertical Jump	33-47 cm	56	0.65	0.78	17-29 cm	52	1.09	0.91
	48-53	59	0.65		30-34	55	0.97	
	>53	55	0.52		>34	57	1.01	
Flexibility (Bender Box)	11-27 cm	56	0.79	0.02	-6-31 cm	54	1.01	0.81
	28-35	54	0.36		32-39	57	0.94	
	>35	59	0.66		>39	53	1.12	
Body Fat (DEXA)	4.5-13.0 %	57	0.53	0.75	4.9-26.3 %	53	0.90	0.57
	13.1-20.1	53	0.68		26.4-32.4	55	0.97	
	>20.1	59	0.63		>32.4	56	1.20	
Body Fat by Skinfold	8.1-14.7 %	47	0.52	0.74	8.1-26.5 %	48	0.95	0.55
	14.9-20.1	61	0.68		26.5-30.2	54	0.92	
	>20.1	62	0.60		>30.2	61	1.20	
Body Fat by Circum	4.9-13.8 %	56	0.62	0.72	10.6-26.6	53	0.96	0.91
	13.9-19.3	56	0.52		26.7-30.9	53	1.06	
	>19.3	58	0.69		>30.9	56	1.08	

APPENDIX F

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